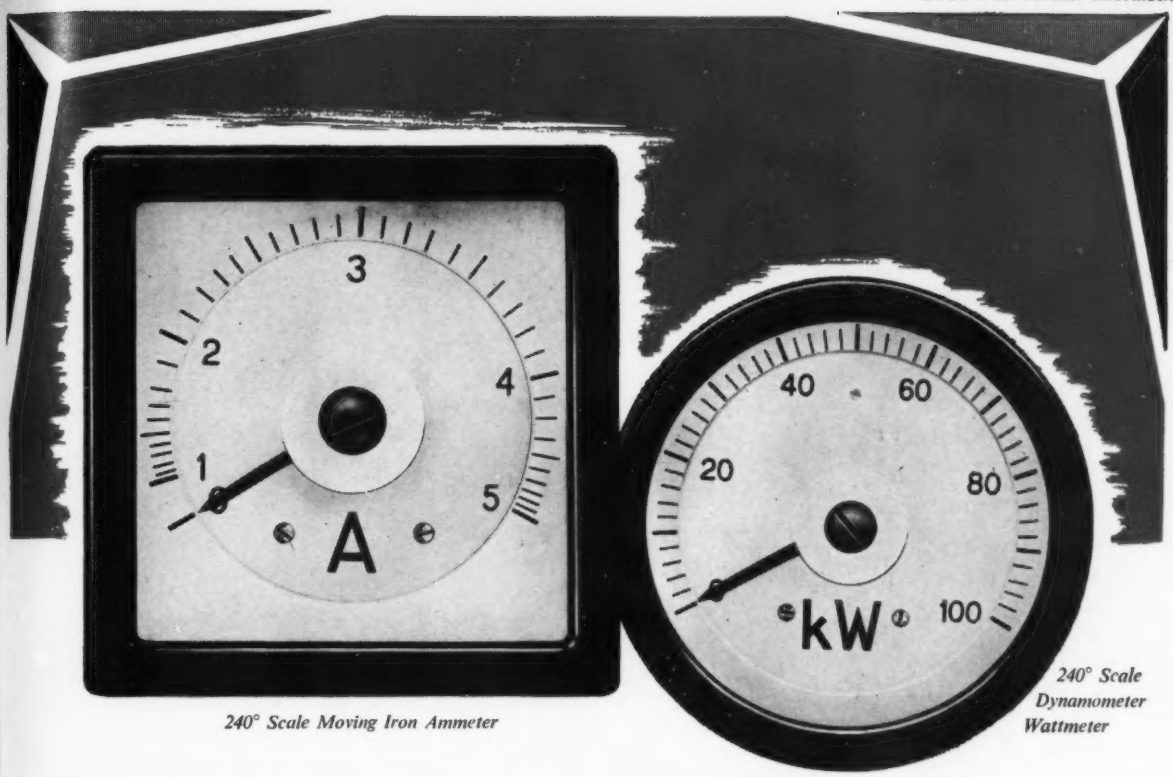
Circle 3 for further information



240° Scale Moving Iron Ammeter

240° Scale Dynamometer Wattmeter

A comprehensive range of 240° SCALE instruments

The switchboard mounting instruments in this range are of an advanced design incorporating many features including platform type scales. The movements are robust in construction and have a high torque/weight ratio. They can easily be dismantled for maintenance purposes and reassembled without disturbance of original accuracy.

Available in low burden types for miniaturised control panel installations, with associated interposing voltage and current transformers.

Types	Moving Iron, Moving Coil and Rectifier Moving Coil Ammeters and Voltmeters, Iron Cored Electrodynamometer single and double element Wattmeters and Varmeters.
Case Patterns	4″, 6″, 8″ Round projecting pattern; 4″, 6″, 8″, 10″ and 12″ Round and Square flush fitting. Pressed steel construction or with cast bezels on larger sizes.
Specification	B.S. 89-1954 Industrial grade or other International Specifications.

Literature available on request to: The ENGLISH ELECTRIC Company Ltd.,
Instrument Department, Stafford.

'ENGLISH ELECTRIC'

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

INS. 46 WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL ACCRINGTON

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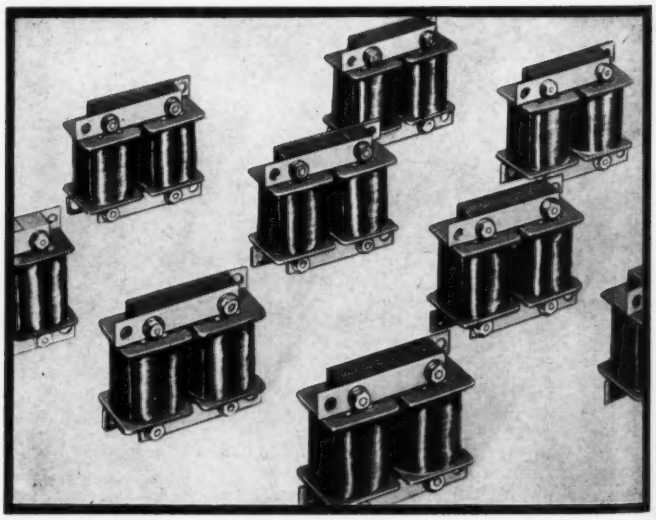
leads to your needs in TRANSFORMERS



One of a range of special transformers and chokes made to customer's specification.

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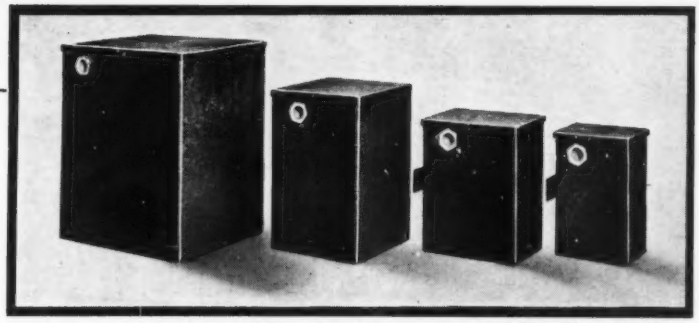
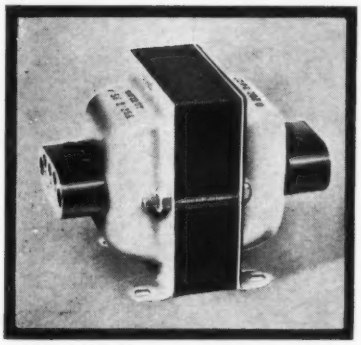
Westool also make: A.C. & D.C. Solenoids, Coils & Coil Winding Machines, Warner Electric Brakes & Clutches, Air Conditioners, etc., and are Sole Selling Agents for the relays, sensing devices and micro-components manufactured by A. P. Besson and Partner Ltd.

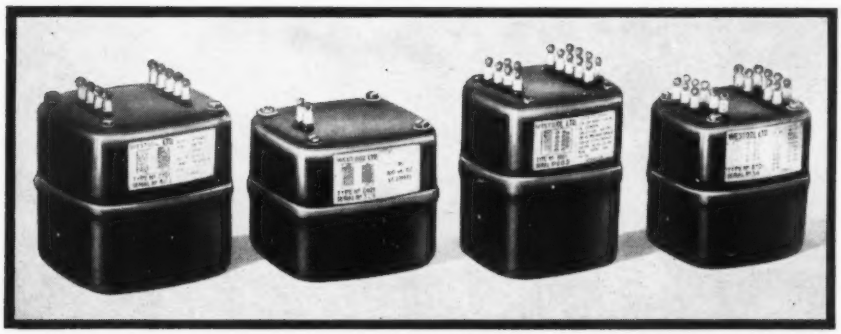
WESTOOL T



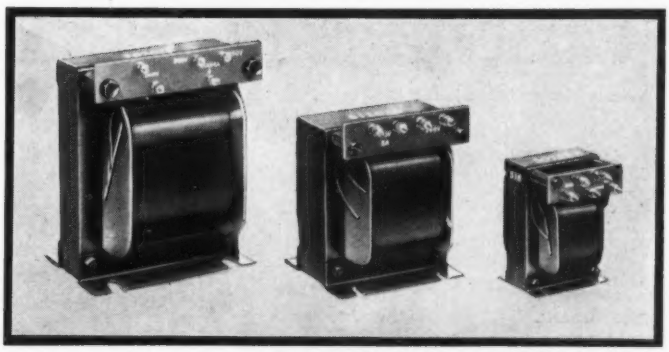
Encased transformer for indoor use made to B.S.171 or B.S.794 in ratings up to 5 KVA single phase and 20 KVA three phase at 50 cps.



Fully shrouded single phase transformer for ratings up to 500 VA at 50 cps.



Hermetically sealed, oil filled, 'C' cored transformers and chokes to RCL 215 for ratings up to 1¼ KVA at 50 cps.



Open type single phase transformers to B.S.171 or B.S.2214 for ratings up to 5 KVA at 50 cps.

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Westool 'know-how' on transformer design and manufacture is based on experience extending over very many years. They specialise in the production of small transformers up to 2,000 VA for sealed can transformers and 5 KVA single phase—18 KVA three phase.

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TRANSFORMERS

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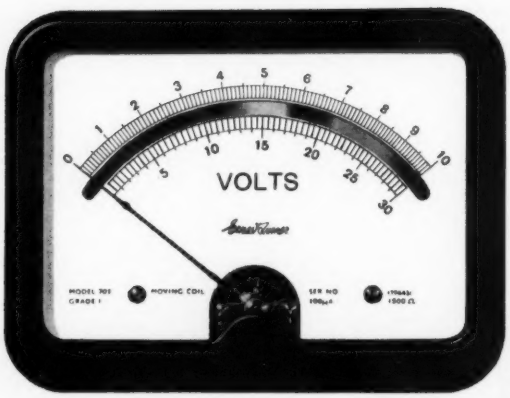

Ernest Turner Electrical Instruments Ltd. HIGH WYCOMBE BUCKS · ENGLAND

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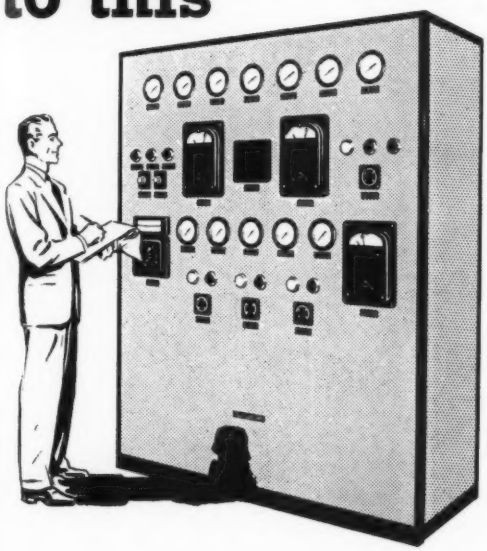
From this to this



and everything between!

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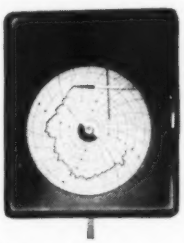
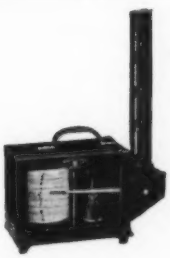


"Mersteel" recording thermometer

Valve positioner



Recording hair hygrometer

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SPECTRUM ANALYSER TYPE 190

The Spectrum Analyser Type 190 is employed to analyse the spectrum of a signal in the frequency range 1-90 kc/s. Characteristic features of this instrument are its high resolution, with a minimum bandwidth of 70 c/s with the response more than 50 dB down at 150 c/s removed from the centre frequency, high threshold sensitivity which is of the order of a fraction of a microvolt, and panoramic displays.

After amplification, the signal is fed to a broadband mixer supplied with reference signal from a heterodyne oscillator sweeping either manually or automatically through the range 101-190 kc/s. The lower sideband of the signal is accepted by a filter centred on 100 kc/s and having a fixed bandwidth of either 70 c/s or 1 kc/s.

Alternative panoramic spectrum display or accurate indication of signal power on a thermocouple milliammeter is provided. Input signal components from 0·1 volt to less than 1 microvolt rms in a 70 c/s band can be measured with an accuracy of ±1 dB.

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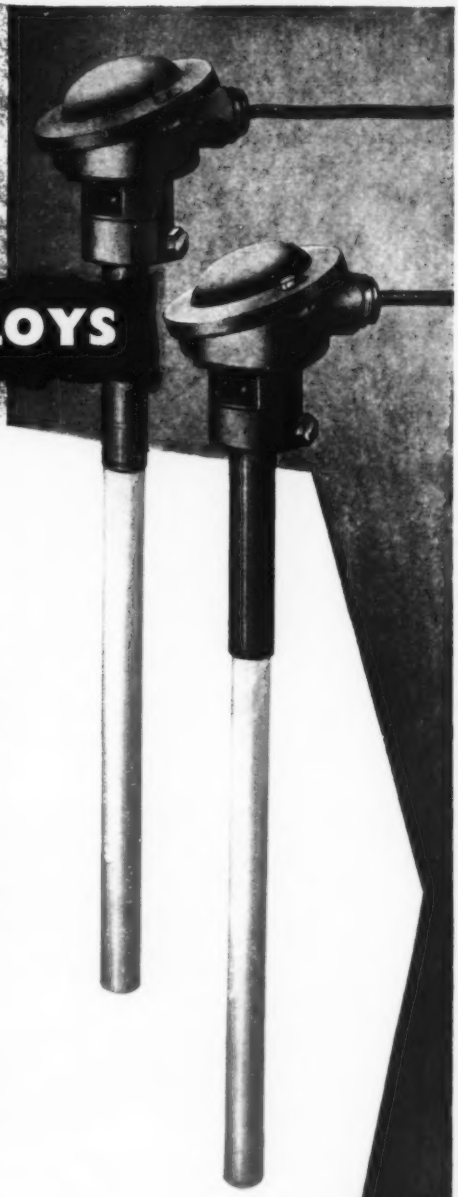
High Temperature

THERMOCOUPLE ALLOYS



"Ni-Cr (plus) v/s Ni-Al (minus)"

Conforming to B.S. 1827:1952

The Thermo-electric properties of the Nickel-Chromium/Nickel-Aluminium Alloys "Ni-Cr(Plus)" and "Ni-Al (Minus)", are in strict conformity with those stated in the American National Bureau of Standards Circular 561, and British Standard Institution Reference Tables for Thermocouples, B.S. 1827:1952.

For Compensating Cables and Extension Leads in Civil and Military Aircraft, "Ni-Cr(Plus)"/"Ni-Al(Minus)" Wires have Ministry of Supply (Air) type approval, for Cables manufactured to Specifications EL. 1705 and 1632.

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CONSTANTAN v PURE IRON
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We manufacture a special quality of Thermocouple iron and are able to supply matched wires in the Iron v Constantan combination to meet customers' varied Thermal-EMF requirements. Furthermore, and of infinitely greater importance, we are able to guarantee the reproducibility of those thermo-electric properties.

When ordering Compensating Leads from your usual supplier, for greater accuracy specify: "Thermocouple Wires made by A. C. Scott & Co. Ltd., preferred".

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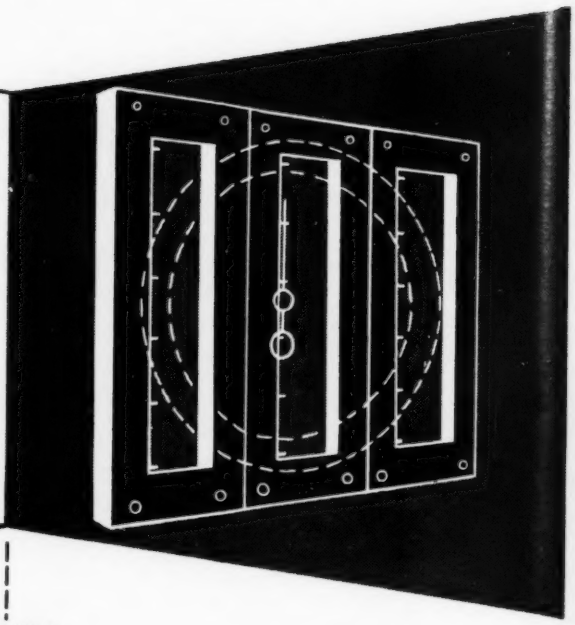
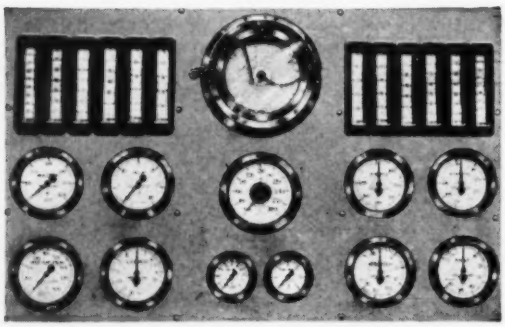
SYDNEY SMITH
FLAT-FACE EDGEWISE
PRESSURE GAUGES

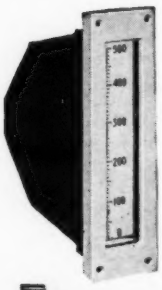


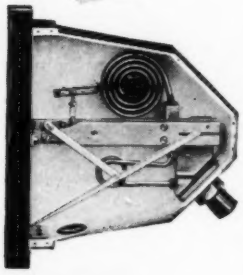
" GRASSHOPPER " PATENT
Size 8" in accordance with B.S.S. 1780-1951.



The TWELVE Edgewise Gauges in the panel above occupy approximately **HALF THE SPACE** *of the ELEVEN conventional dial type.*

Being Flat-Faced there is no Glint





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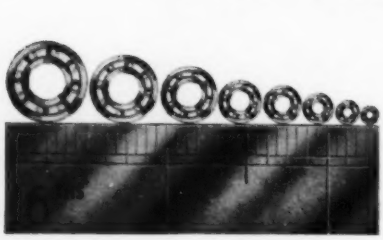
*After the photograph was taken the ladybird flew away home.

LADY *Hercules!*

Who would think a ladybird could carry 15 times its own weight. This one is doing it easily and happily.* The load is a 4 m.m. Hoffmann Miniature Ball Bearing. Even more startling is the fact that this bearing can carry 16,000 times its own weight, viz., 4 lbs. at 100 r.p.m. A range of Hoffmann Miniature Ball Bearings is made from ½" down to 3 m.m. outside diameter, to B.S.I. limits, or if required, to specifications ABEC 3, 5 or 7.

HOFFMANN

THE GREAT LITTLE BEARINGS



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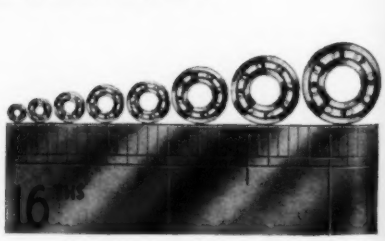

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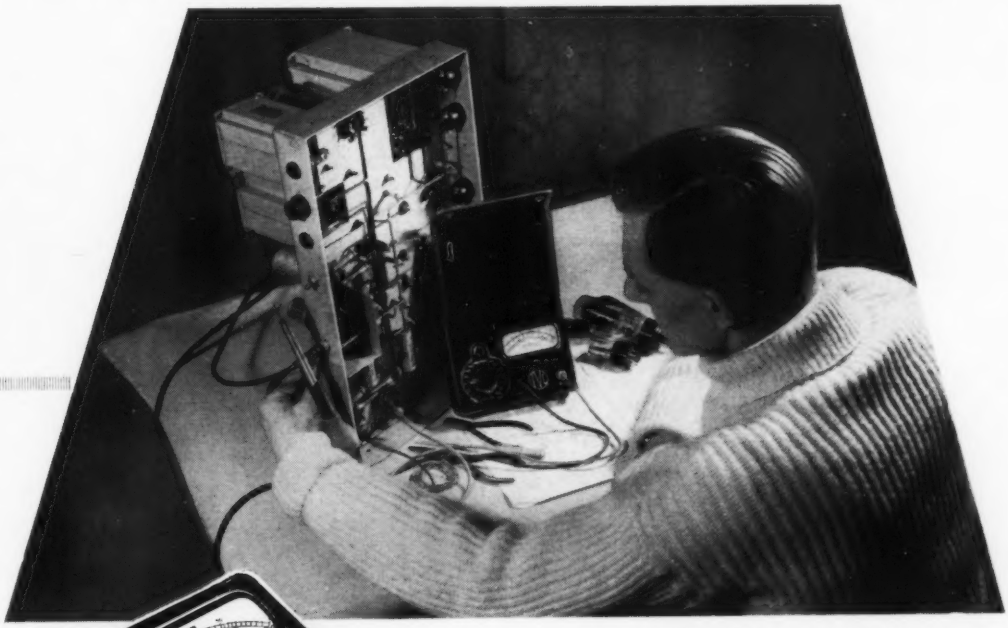
Indispensable...



Using an AVO Multiminor to balance the D.C. component across the output transformer of a High Fidelity Amplifier.

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D.C. Voltage: 0-1,000 V in 7 ranges
A.C. Voltage: 0-1,000 V in 5 ranges
D.C. Current: 0-1A in 5 ranges
Resistance: 0-20,000Ω. 0-2MΩ

Sensitivity:
10,000Ω/V on D.C. voltage ranges
1,000 „ „ A.C. „ „

Accuracy:
3% of full scale value on D.C.
4% „ „ „ „ „ A.C.

THIS is an ingeniously designed yet inexpensive rectifier/moving coil instrument of pocket size and sturdy construction. It is extremely well made and simple to use.

It is fitted with a high-grade rotary selector switch of quite unique design, in which a series of 18 fixed silver-plated contacts, embedded in a moulded ring, are wiped by a double-contact rotor arm.

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Size: 5¼ × 3¼ × 1¾ inches.
Weight: 1 lb. approx.

List Price: **£9 : 10s.**

Complete with Test Leads and Clips
Leather Case if required **32/6**

Write for your Free Illustrated Catalogue describing the complete range of AVO instruments.

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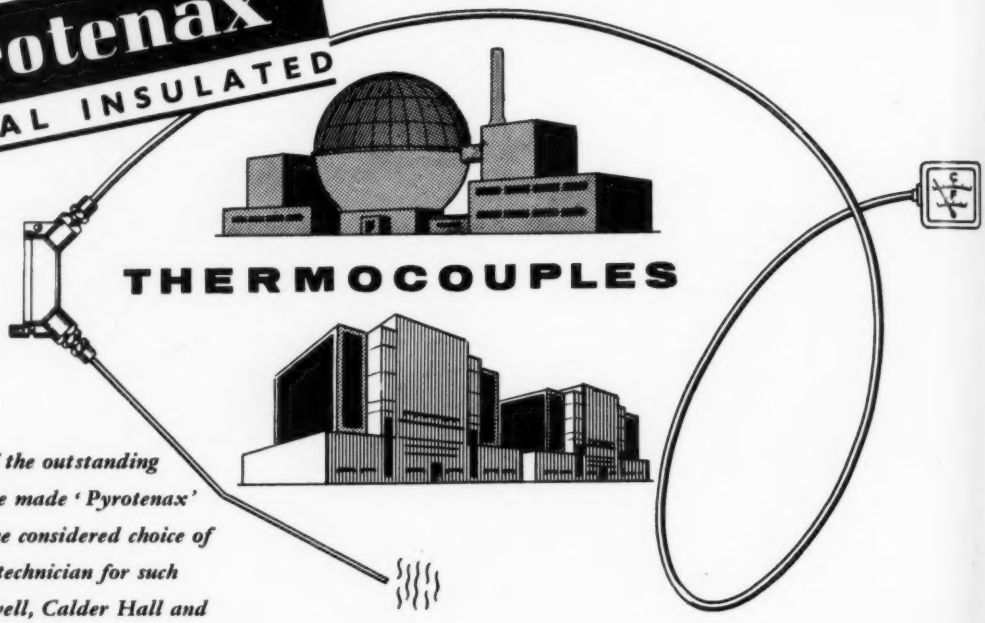
FEATURES THAT PROMPTED THE CHOICE OF

Pyrotenax

MINERAL INSULATED



THERMOCOUPLES

Here are some of the outstanding features that have made 'Pyrotenax' Thermocouples the considered choice of the scientist and technician for such projects as Bradwell, Calder Hall and Dounreay and in ever increasing quantity in Thermo-instrumentation generally.

EASILY BENT TO SHAPE

they are

IMMUNE FROM THERMAL SHOCK AND MECHANICAL DAMAGE

their

SMALL OVERALL DIAMETER

permits use in restricted spaces allowing simultaneous readings at different points, where normally only one conventional type could be sited, and generally

NO ADDITIONAL PROTECTIVE SHEATHING REQUIRED

resulting in a

RAPID RESPONSE RATE

comparable with that of mercury-in-glass thermometer

They have a

LONG LIFE

but, because they are

INEXPENSIVELY REPLACED

they may be used at temperatures far in excess of those normally permitted for economic operation.

'Pyrotenax' Thermocouples are supplied with conductors of COPPER/CONSTANTAN with either CUPRO-NICKEL or MILD STEEL sheath, conductors of NICKEL-CHROME/NICKEL ALUMINIUM ALLOY with NICKEL-CHROME STEEL sheath for high accuracy, high temperature applications.

Full technical details in Publication 31/U109.

PYROTENAX LIMITED

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Telephone: Hebburn 83-2244/8

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GD109

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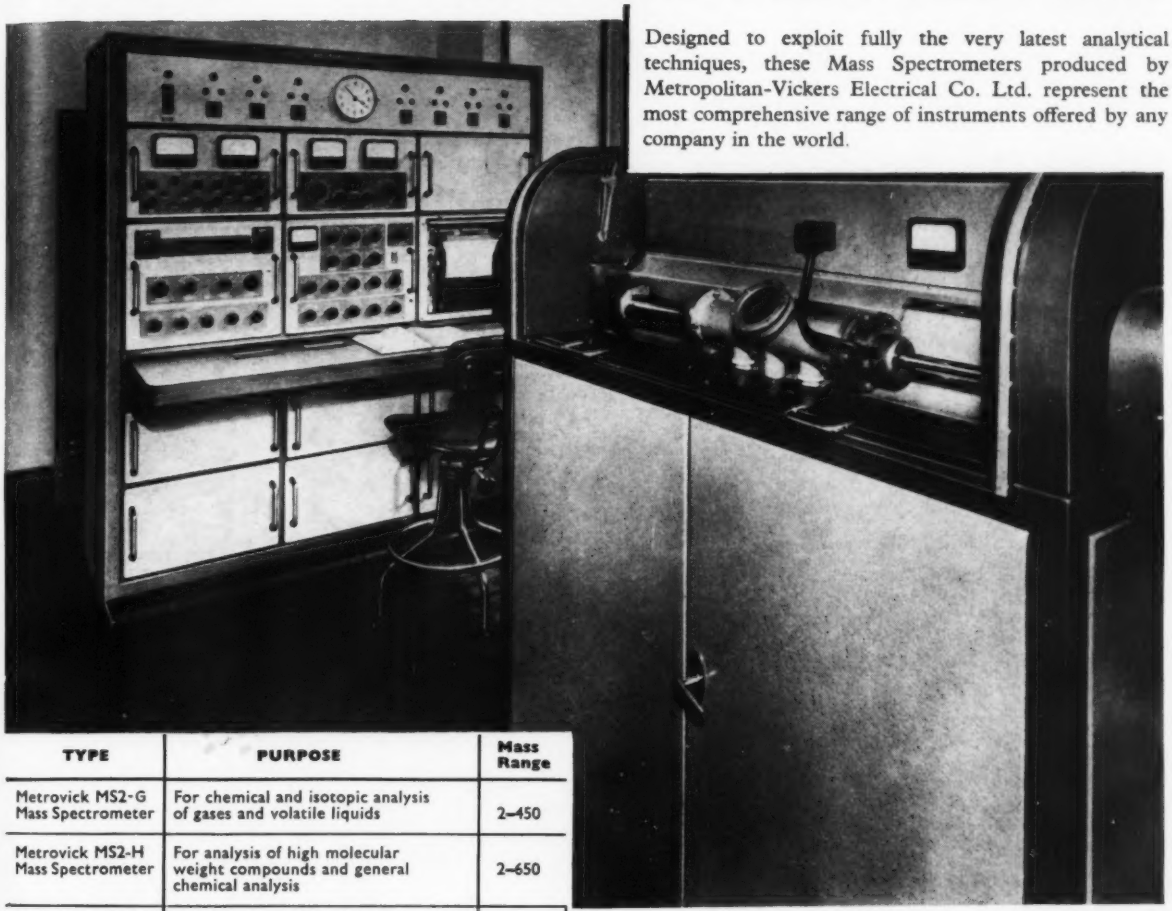
The world's most extensive range of

MASS SPECTROMETERS



Designed to exploit fully the very latest analytical techniques, these Mass Spectrometers produced by Metropolitan-Vickers Electrical Co. Ltd. represent the most comprehensive range of instruments offered by any company in the world.

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Metrovick MS2-G Mass Spectrometer	For chemical and isotopic analysis of gases and volatile liquids	2–450
Metrovick MS2-H Mass Spectrometer	For analysis of high molecular weight compounds and general chemical analysis	2–650
Metrovick MS2-S Mass Spectrometer	For isotopic analysis of solids using surface ionisation techniques	2–450
Metrovick MS2-SG Mass Spectrometer	For isotopic analysis of solids and gases	2–450
Metrovick MS2-X Mass Spectrometer	For isotopic analysis of uranium hexafluoride and similar compounds	2–450
Metrovick MS3 Mass Spectrometer	For chemical and isotopic analysis of gases and volatile liquids in the low mass range	2–130
Metrovick MS4 Mass Spectrometer	For respiratory gas analysis	18–48
Metrovick MS5 Mass Spectrometer	For routine isotopic analysis of solid samples using surface ionisation techniques	6–400
Metrovick MS6L Mass Spectrometer	For gas leak detection using helium as tracer For gas leak detection using methane as tracer For gas leak detection using argon or butane as tracer	4–32 14–56 30–120
Metrovick MS7 Mass Spectrometer	For analysis of impurities in solids, such as metals, alloys, semi-conductors, graphite, etc.	7–240
Metrovick MS9 Mass Spectrometer (*Replacing type MS8*)	This is a very high resolution spectrometer for qualitative and quantitative analysis of organic compounds	—

***At Oxford University**—A Metrovick MS5 Mass Spectrometer recently installed at the Department of Geology and Mineralogy.*

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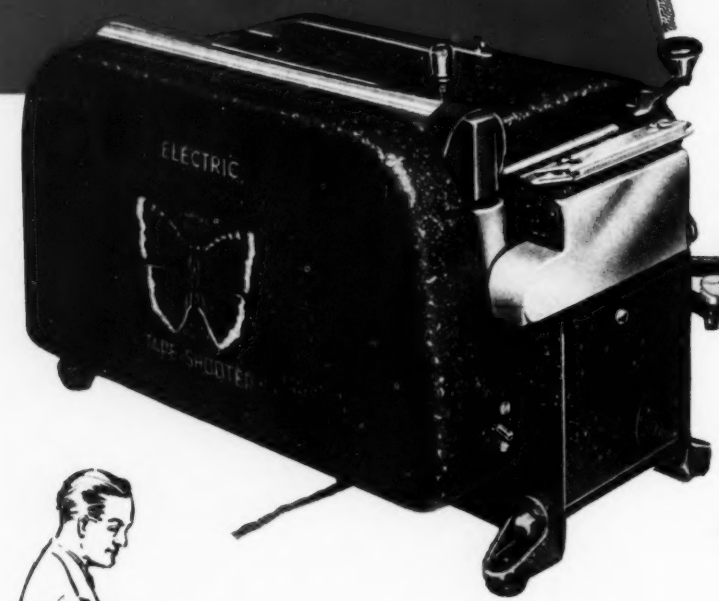
"THE SEAL-IN-A-SECOND"

ELECTRIC TAPE SHOOTER

--- with the 'feather touch' control



★ THE HIGH SPEED PRESS - BUTTON GUMSTRIP (REGD.) SEALING TAPE SHOOTER

- SAVES FATIGUE IN PACKING
- SAVES TAPE BY PRE-SET LENGTHS
- AUTOMATIC MOISTENING CONTROL
- MORE PARCELS PACKED PER DAY
- DESIGNED FOR RAPID SEALING OF HEAVY BALES, CARTONS AND CONTAINERS
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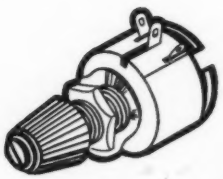
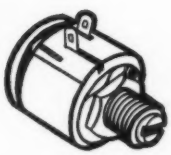
THE NEW POTENTIOMETER
Type PV2

This new miniature Wirewound Potentiometer is fully type-approved to R.C.S.C. styles RVW 13/14.





RATING
2 watts at 20°C.

Illustrated are some of the styles available

Available with normal shaft for knob operation, slotted shaft for preset adjustment by screwdriver, and longer slotted shaft with split collet locking device. All styles can be supplied with or without panel seals.

A wide air gap at the back of the component prevents condensation in humid conditions.

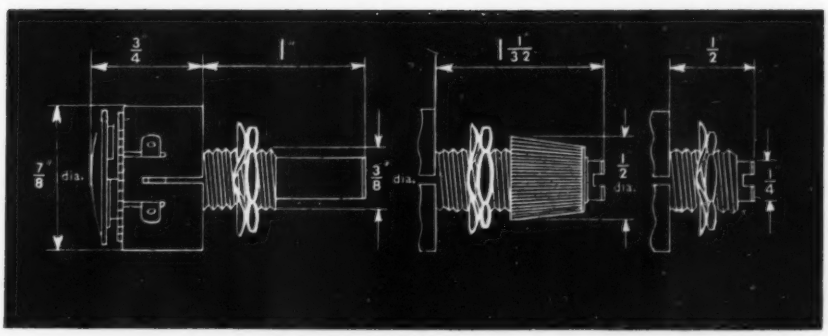
The resistance element is of copper-nickel wire for the lower values and nickel-chrome wire for the higher values; both are wound in strip form on a bakelite laminate of high electrical quality.

The resistance wire is welded at each end to an interwire, which is soldered to the connecting tag. The three tags are of plated brass and project through slots in the shell.

Contact ring and wiper arms, the tips of which are rhodium plated, are nickel silver. Shaft bush and nut are nickel-plated brass.

The lockable shaft model has a long bush with split conical extension at the end. The shaft is locked by a milled sleeve screwed over the bush compressing the split cone.

Write for technical leaflet



Painton & Co. Ltd.
KINGSTHORPE NORTHAMPTON
Tel: 32354/7 Telegrams: 'Ceil, Northampton'

Circle 19 for further information

At your Service...

This man is one of the Foster Instrument Company's Service Engineers. He is just setting out on an emergency call to a large engineering works in the Midlands where a breakdown has been reported. He will travel over fifty miles, find the fault, set the equipment working again and be on his way to a regular service Contract appointment after lunch. That call will have cost the customer a worrying few hours, a stoppage of production and lost time for several operatives — and it could well have been avoided by using the Foster Service Contract Scheme.

Briefly this scheme, which has been in successful operation for over 20 years, covers periodic visits by our Service Engineer to examine, adjust and certify (to A.I.D. requirements) the accuracy of our temperature measuring equipment. The visits can be arranged at 3, 6 or 12 monthly intervals according to the customers' requirements and the charges are very reasonable. If you use Foster instruments do write to us for details of this scheme — wherever you are in England, Scotland, Wales or Northern Ireland.

N.B. Extract from customer's letter—

"We have in use a pyrometer of your manufacture, purchased from you apparently in 1918 . . . We are pleased to say that this instrument is still giving good service . . . . but we now require a new Thermocouple."

We know that this sort of performance is inherent in Foster instruments, but we still recommend our scheme as being the key to maintained accuracy.

REGALIA FOSTER

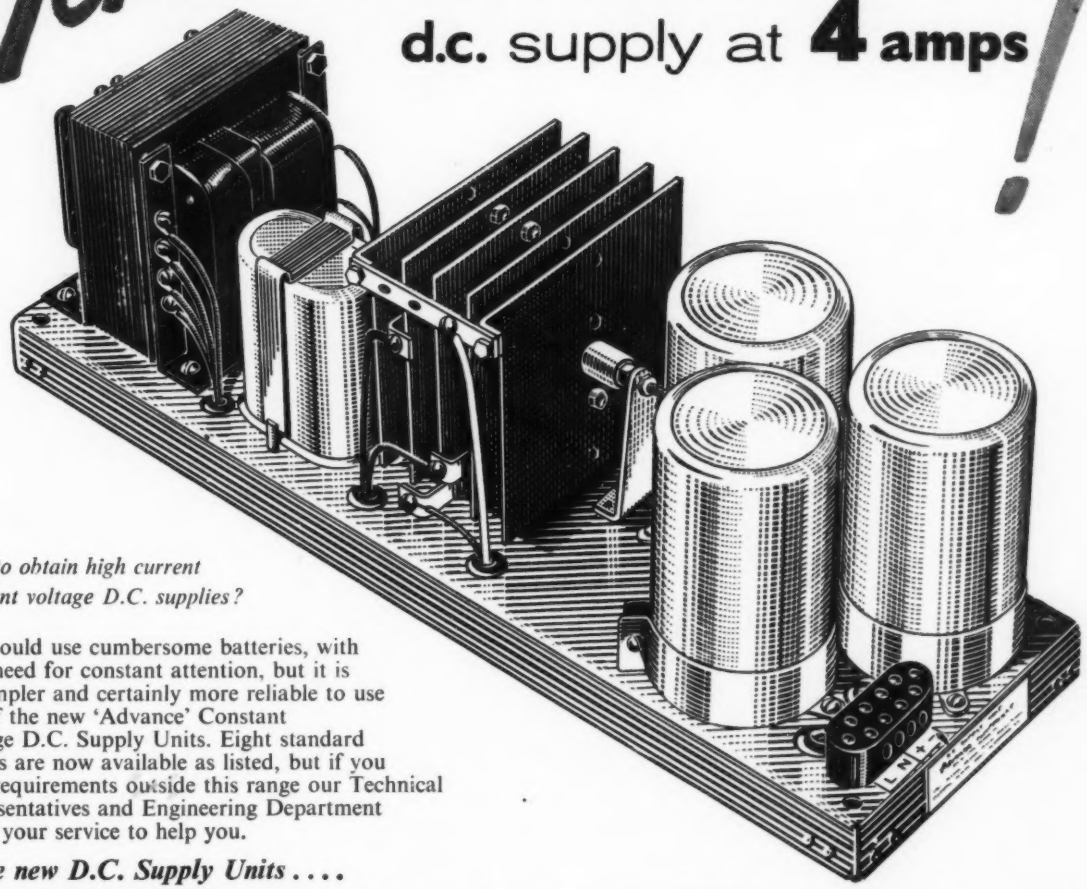
"The Pyrometer People"

FOSTER INSTRUMENT CO LTD
Letchworth, Herts, England.
Telephone: Letchworth 984/5/6

Members of S.I.M.A. and B.I.M.C.A.M.

Circle 20 for further information

Here is a 12v. stabilized d.c. supply at 4 amps!



How to obtain high current constant voltage D.C. supplies?

You could use cumbersome batteries, with their need for constant attention, but it is far simpler and certainly more reliable to use one of the new 'Advance' Constant Voltage D.C. Supply Units. Eight standard models are now available as listed, but if you have requirements outside this range our Technical Representatives and Engineering Department are at your service to help you.

These new D.C. Supply Units . . . .

- Provide **HIGH CURRENT OUTPUT AT LOW COST**
- Are **SMALL IN SIZE AND WEIGHT FOR VA OUTPUT**
- Have **HIGH ENERGY RESERVOIR,** thus are suitable for pulse, intermittent or variable loads
- Operate with **HIGH EFFICIENCY**

TYPE	OUTPUT RATINGS		NETT PRICE in U.K.
DC/6/1.25	6 volts	1.25 amp	£15
DC/6/4	6 volts	4.00 amps	£25
DC/12/1.25	12 volts	1.25 amp	£20
DC/12/4	12 volts	4.00 amps	£30
DC/24/1	24 volts	1.00 amp	£25
DC/24/5	24 volts	5.00 amps	£45
DC/48/1	48 volts	1.00 amp	£35
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Advance CONSTANT VOLTAGE

D.C. POWER SUPPLIES

Full technical details available in Leaflet C59

Advance COMPONENTS LIMITED · *Mains Stabilization Division*

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PYROMETER CONTROLLER

Embodying an extremely simple circuit without the use of any electronic components, transistors, lenses or reflectors, the Coley Z5 will control with an accuracy of ·25% at any temperature up to 1600°C.

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by sefram of paris

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- *Incorporates patented SCHLUMBERGER-PICARD galvanometer elements.*
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A 6V. lamp is used and fed through a built-in transformer with mains selector for 115-130-220-240-volts, A.C. or directly on 6 volts D.C.

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protects flame-traps

from the dangers of blow-back flames

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ETHER FLAME-TRAP ANCILLARY UNIT

Patent applied for

TYPE 350

This new safeguard, the ETHER Flame-Trap Ancillary Unit, Type 350, will be invaluable in industries where pre-aerated gas or pre-mixed gases are used. At present, a flame-trap is normally provided to arrest the flame temporarily when a blow-back occurs, but unless it is noticed, the flame will ultimately burn through the flame-trap.

Now this hazard need no longer exist. The ETHER Type 350 introduces a detector in front of the element of the flame-trap by means of which the supply of gas is shut off, or an alarm given, within a fraction of a second of a blow-back occurring.

The Type 350 is foolproof, compact and low in price. It can readily be adapted to fit all existing flame-traps. Illustrated technical data forwarded on request.

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Representatives throughout U.K.; agents in all principal countries.

ETHER (LIMITED)

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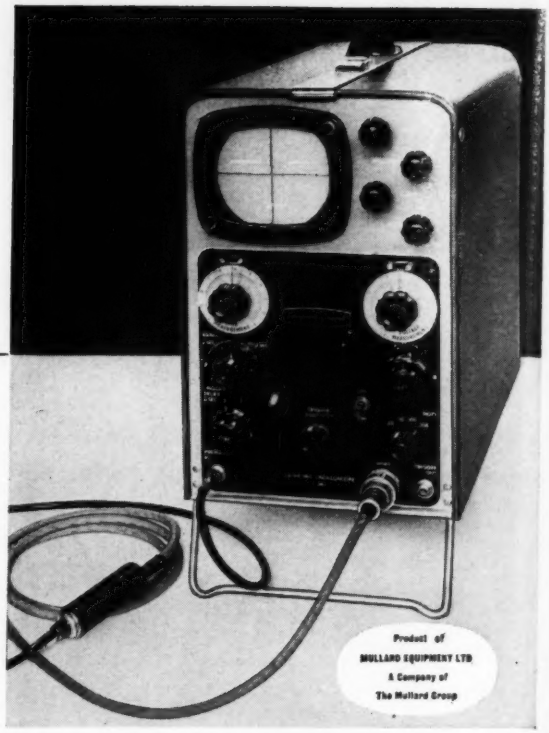
The oscilloscope with 2 Milli-micro seconds rise time



Extremely compact & portable · Sensitivity 150 mV/cm
Can handle repetitive pulses of random separation
Bright display · Inexpensive

Working on a novel sampling principle, the L362 provides nucleonic and electronic engineers with an inexpensive oscilloscope capable of recording pulses of extremely short duration.
The L362 oscilloscope has been developed from a design originated by the United Kingdom Atomic Energy Authority Research Establishment, Harwell.

DIMENSIONS: *only 14½ in x 8¾ in x 18 in and weight 27 lb. (12·2 kg)*

Write for full technical details:—

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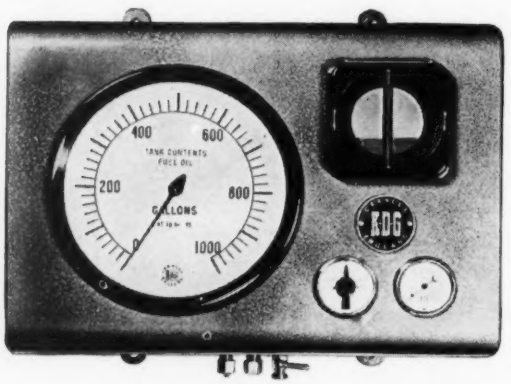

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Instrument and all accessories housed together as one unit, giving complete and accurate picture of storage, air flow and pressure conditions at a glance.
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Additional indicators available for alternative reading positions.
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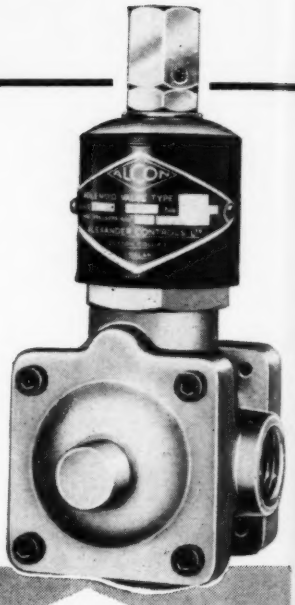

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It is our belief that there are occasions when performances are far more eloquent than words. The present instance is a case in point. TMC Carpenter Polarized Relays and TMC Polystyrene Capacitors are fitted to the Short Brothers and Harland Analogue Computor, the first instrument of its kind in the world and used by Handley Page Ltd., for the vitally important task of making aerodynamic calculations for the design and construction of the VICTOR.

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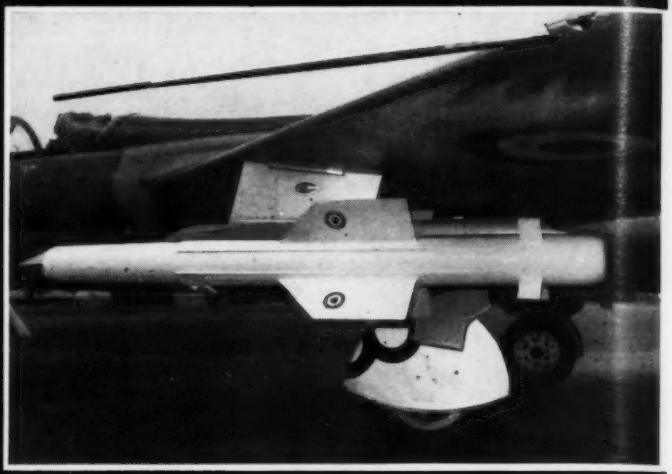
On Target

TELCON METALS
AND THE DE HAVILLAND
FIRESTREAK



We are proud to be associated with DE HAVILLAND PROPELLERS LTD., in the manufacture of the FIRESTREAK guided missile.
The majority of electronic assemblies used in this missile embrace components which depend on our alloys – MUMETAL, RADIOMETAL and H.C.R. – for their exacting operation.
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Norgren equipment gives you highest efficiency and reliability from pneumatic instruments. Air line Filters keep the air clean, dry and free from impurities. Pressure Regulators ensure a steady and correct working pressure for the instruments. The Norgren range covers all requirements – write or phone for full details.

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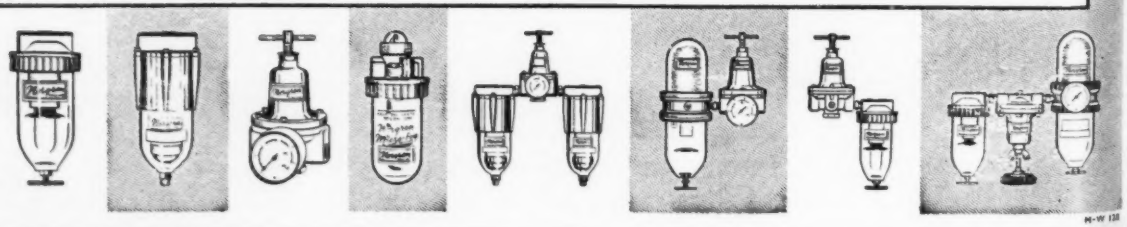

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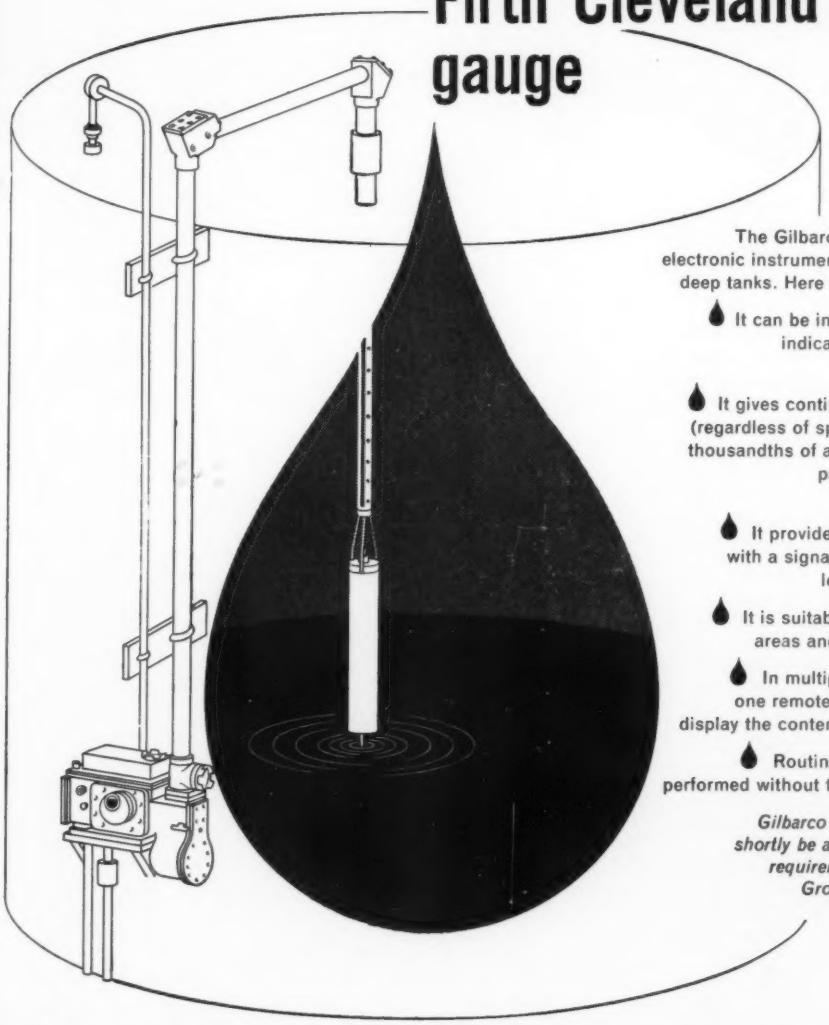
Circle **32** for further information

this is the GILBARCO Firth Cleveland gauge



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Gilbarco Gauges of our production will shortly be available to Buxton flame-proof requirements or to American Class 1, Group D, Division 1 classification

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LONDEX

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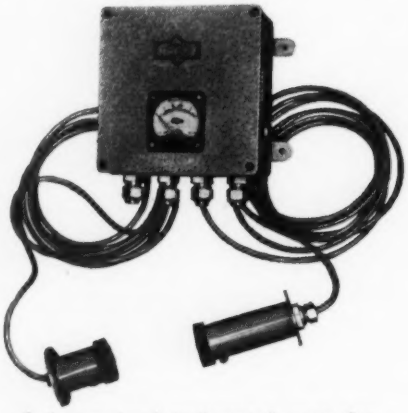

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Using a photo-transistor as light-sensitive device and containing no valves, this new Londex equipment is extremely compact, robust and reliable. It comprises simply a projector head, photo-transistor head and a control unit which incorporates the low-voltage supply for the projector. A meter enables correct alignment of the light projector and photo-transistor head to be made with ease.

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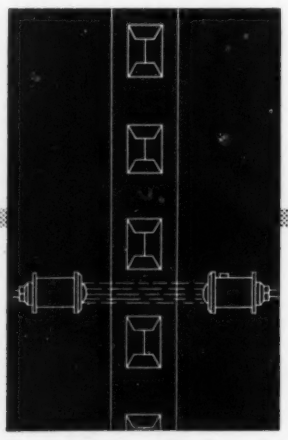
A version is available with built-in 5-figure counter.



Illustrated catalogue and price list of photo-electric equipment gladly sent on request.

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Portable . . .

TYPE MC—1 (MK.III)

CONDUCTIVITY MEASURING BRIDGE

The type MC—1 portable electrolytic conductivity measuring bridge is a truly portable instrument designed to give long and trouble free service in the laboratory or in the field.

The instrument, which is now used by the Electricity Generating Stations and the principal Water Purification Engineers throughout the country, is supplied complete with an ELECTRONIC SWITCHGEAR patented, non-glass, conductivity measuring cell and all accessories, in a convenient hardwood carrying case. The development of low power consumption transistorized circuits, which operate from a small long life dry battery, has resulted in the production of a particularly compact and light-weight precision instrument.

The range of measurement is from $0{\cdot}1$—10^6 micromhos/cm^3.

Price
£66

DESCRIPTIVE LEAFLET MC AVAILABLE ON REQUEST

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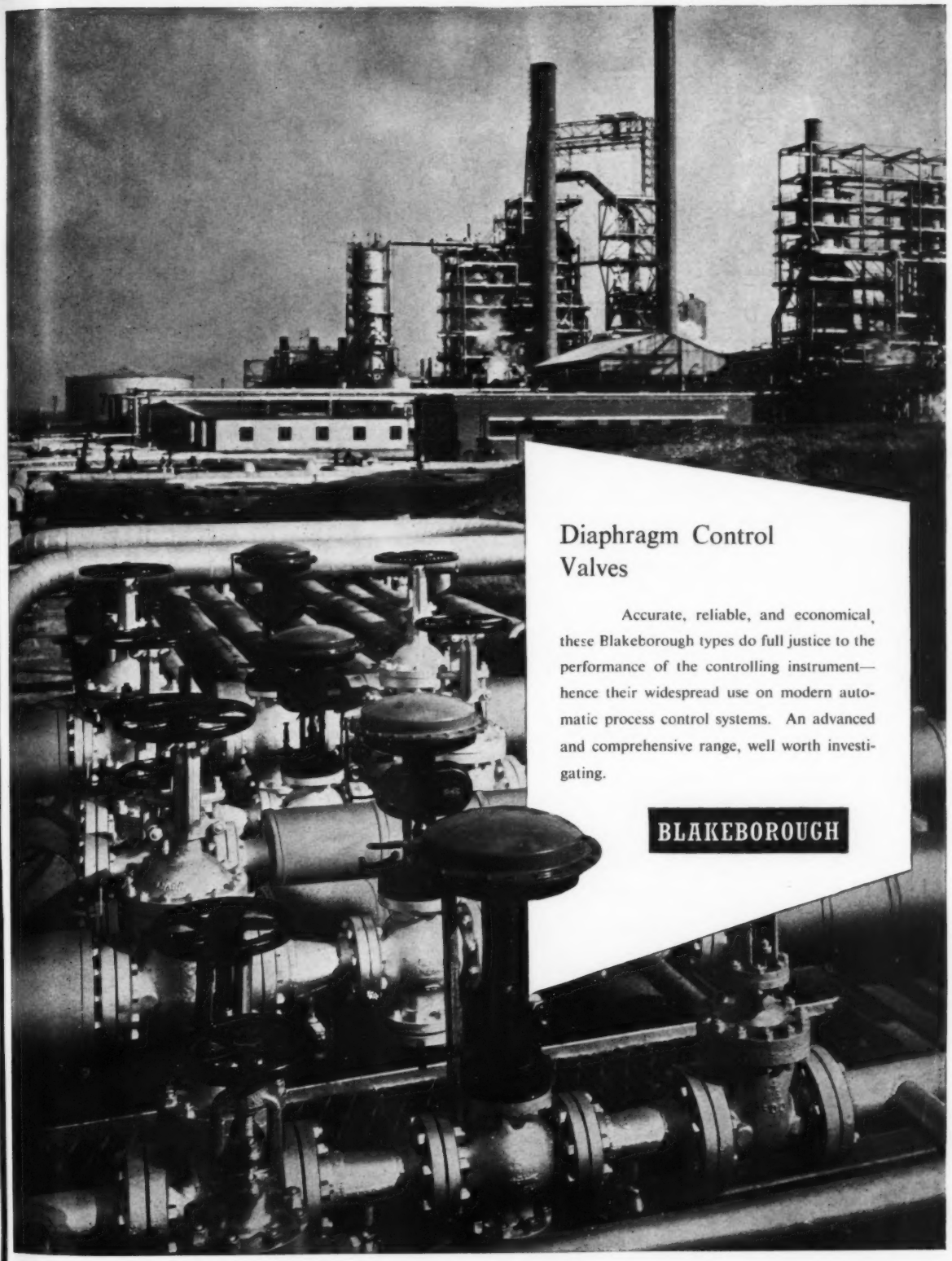

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Accurate, reliable, and economical, these Blakeborough types do full justice to the performance of the controlling instrument—hence their widespread use on modern automatic process control systems. An advanced and comprehensive range, well worth investigating.

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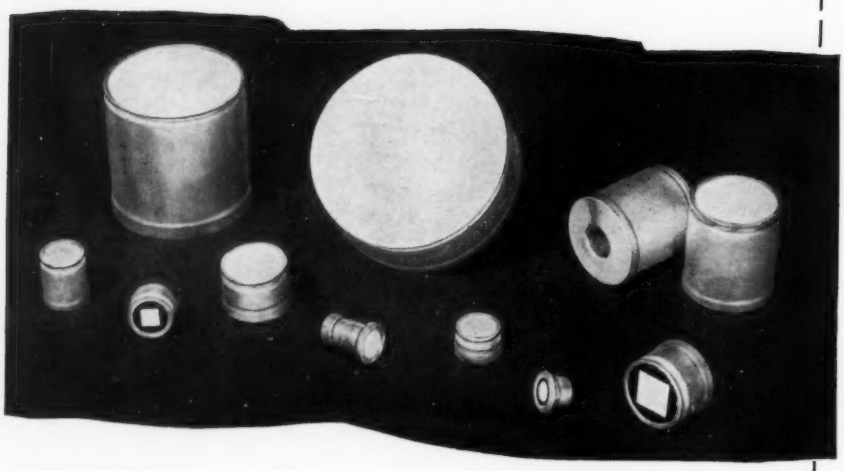

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. . . by its hump—or from the expression on its face for that matter. But one glance at a P & G pressure gauge reveals an instrument of quality, made by craftsmen to ensure accuracy and dependability for a very long time. This is no mirage—see one for yourself.

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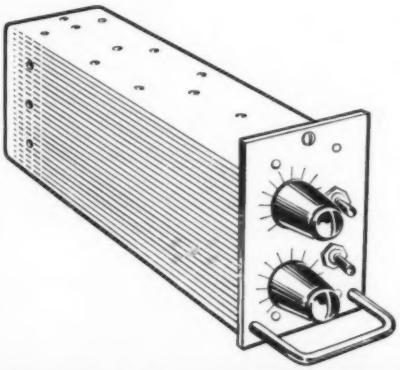
Circle 38 for further information

A.W.A

ELECTRONICS

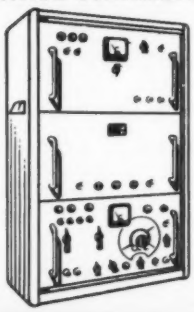
New concepts in electronics have been developed at AWA, as a result of experience with missile systems. Now they have a wider application. Here are some of the new AWA devices now available to industry.

TRANSISTOR GALVANOMETER AMPLIFIER



This Amplifier has been designed to drive viscous damped recording galvanometers which normally have a resistance of 50 ohms and a working range of D.C. to 2 Kc/s in frequency. The amplifier has a switched attenuator at its input and will accept single ended or push pull signals from ± 1 Millivolt to ±500 volts and will feed a maximum of ±50 Milliamps to the galvanometer. There is also a range of ancillary units available for use with this Amplifier as part of a comprehensive instrumentation system. *Standard specification: Dimensions: 4¼ in. x 3¾ in. x 10 in.; Frequency response: Flat from DC to 2 Kc/s, 5% down at 3 Kc/s, 3db down at 6 Kc/s; Noise level: less than 10 Microvolts; Input impedance: 40,000 ohms on range 5, 110,000 ohms all other ranges; Gain: Maximum 7.5 Milliamps/Millivolt, minimum 0.04 Milliamps/Volt; Power requirements: ± 6 Volts D.C. 220 Milliamps each line.*

COMEL 8 & 12 SWEEP OSCILLATOR AND VIBRATION CONTROLLER



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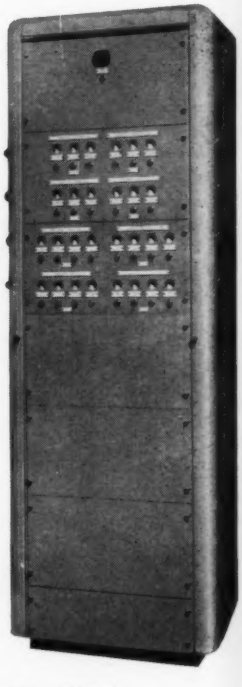

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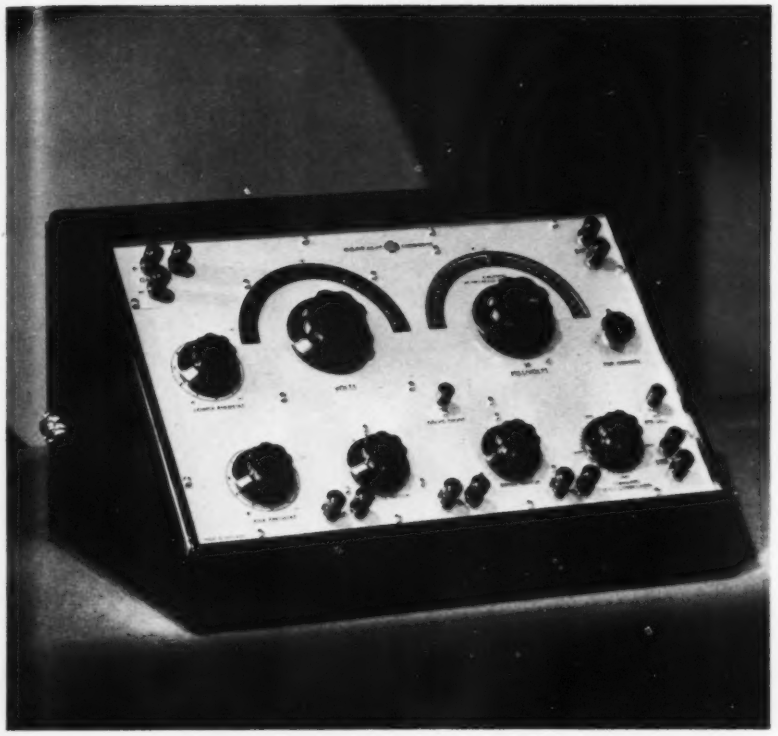

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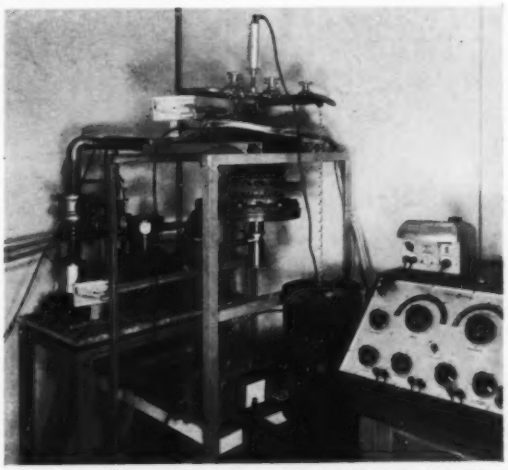

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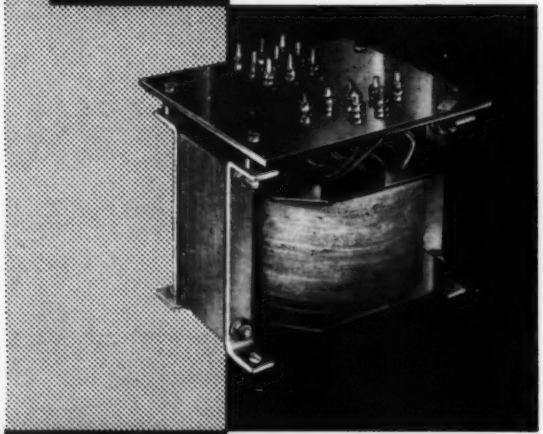

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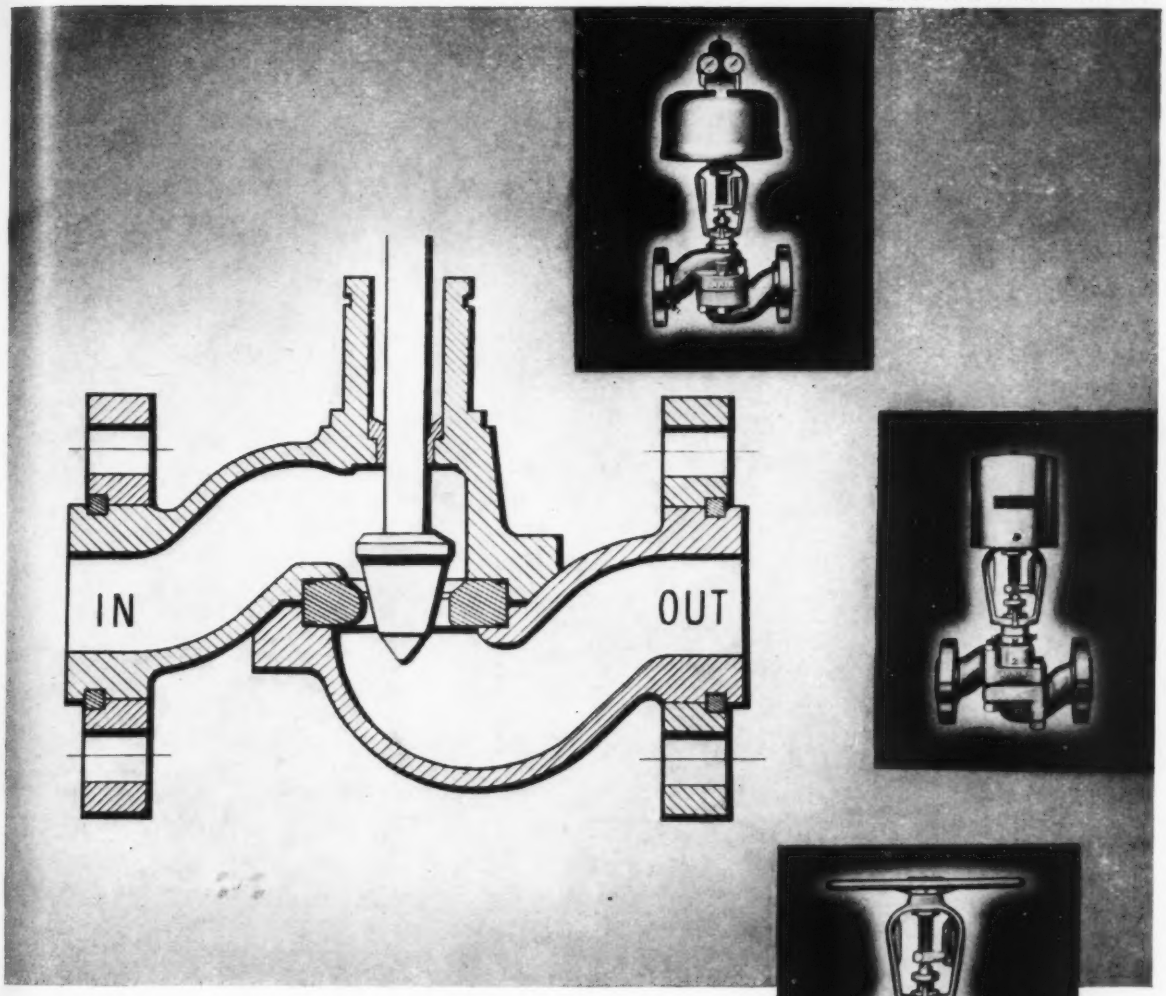

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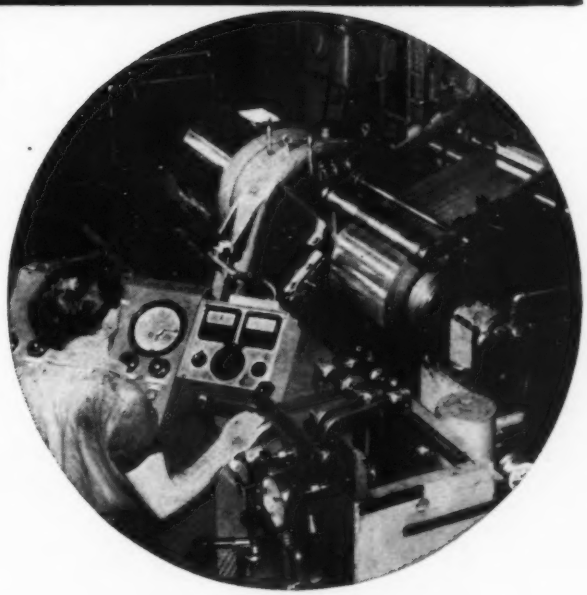

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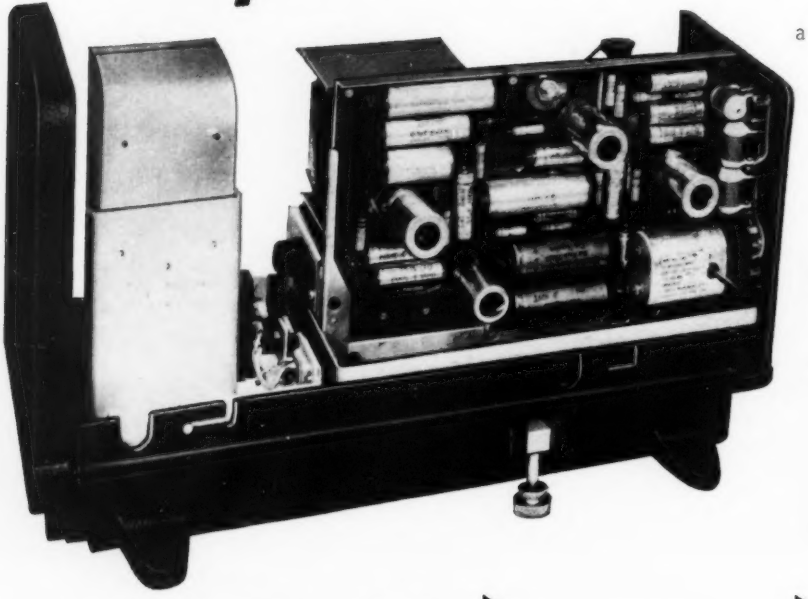

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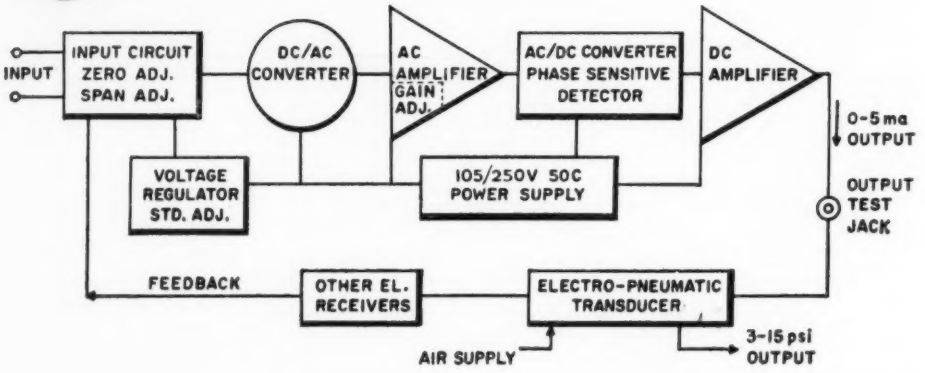

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INSTRUMENT Practice AUTOMATION & ELECTRONICS

Editor: J. T. Miller, B.Sc., F.Inst.P.

VOL. 13. No. 6

CONTENTS June 1959

	Page
The Robotug, E.M.I. Driverless Trolley System	615
Standardisation of Variable-area Flow Meter Scaling	618
Electro-pneumatic Sequence Control Equipment	620
The Education of Instrument Technologists and Control Engineers *By J. F. Coales, O.B.E., M.A., F.Inst.P.*	623
Computers and the Electronic Office. Part 2. Production Control *By R. H. Williams, A.I.B., F.Inst.D.*	632
B.C.U.R.A. 21st Anniversary Open Days	637
R.E.C.M.F. Exhibition, 1959	638
Transistors in Measurement and Control—2 *By J. T. Miller, B.Sc., F.Inst.P.*	640
Fifth International Instrument Show	643
X-ray Image Amplifier	645

Regular Features

Commentary	613	News of the Industry	661
Book Review	622	Personalities	669
New Patents	635	Publications Received	669
New Instruments	647	Society of Instrument Technology	670
Manufacturers' Publications	658		

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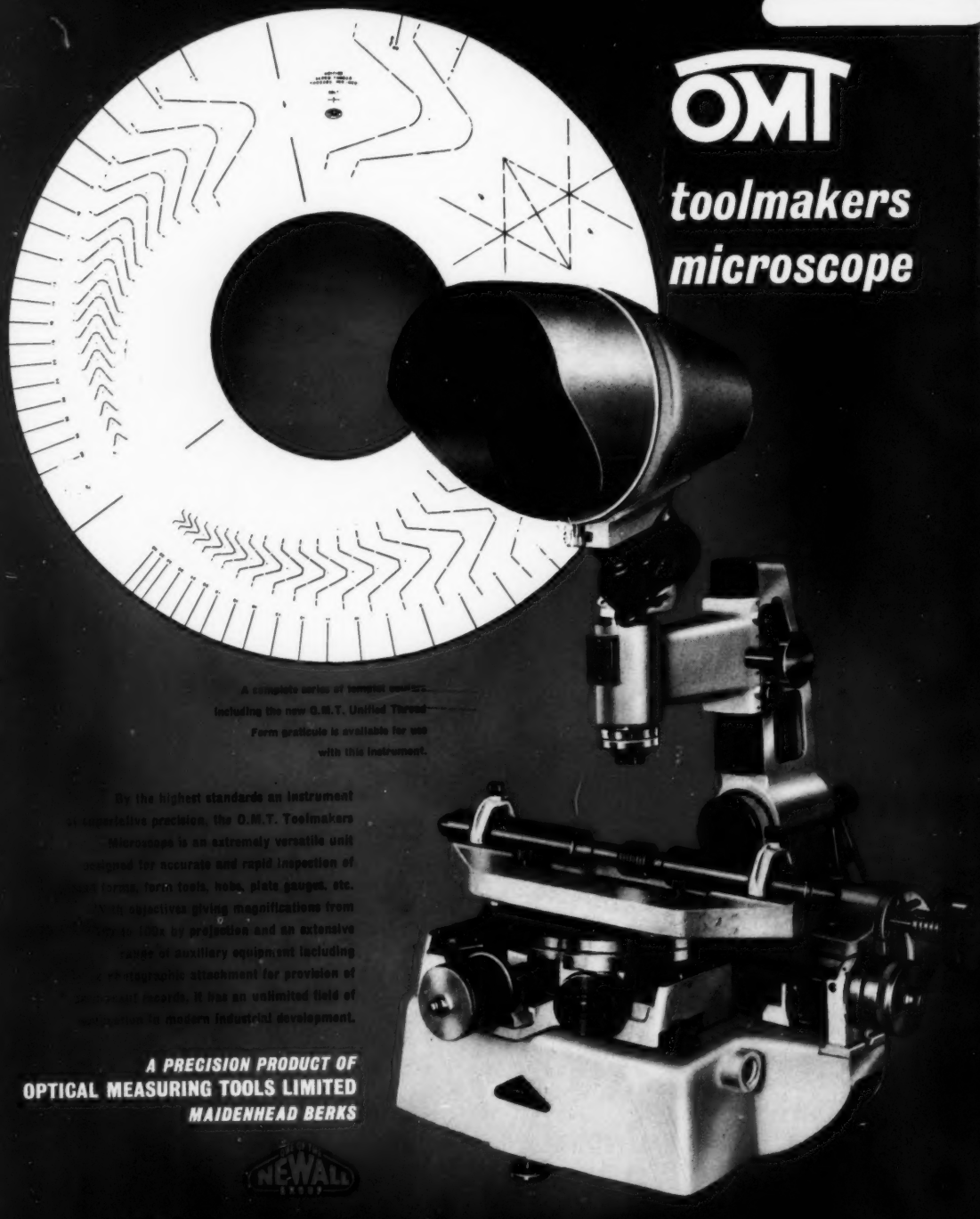

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COMMENTARY

Standard of Articles

The Radio Industry Council awards, annually, premiums to the writer or writers of articles published during the year which, in the opinion of the panel of judges, are "likely to enhance the reputation of the British electronic industry and focus attention of the world on Britain's leadership in the field of radio, television and electronics".

At the recent presentation luncheon, Air Marshal Sir Raymund G. Hunt, the Director, had the following remarks to make:

"I wish to thank the panel of judges who have been responsible for assessing the articles submitted. They have a task which is becoming more difficult each year because the standard of the articles submitted is changing. The good articles are of an increasingly high standard, but sad to relate, the not-so-good ones are well below the standard that is required.

"In most cases the articles selected for the premiums do not satisfy in full the criteria laid down for the guidance of the panel of judges, and one article so selected fell far short of the standard expected in respect of presentation and good English. This particular article earned an award for the writer by the excellence of the material it contained. I wish to emphasise that whatever happens there is no intention of lowering the standard.

"The intention of the Council when it initiated this scheme was to encourage an increased flow of articles from within the industry for the technical Press. This demands a polished and accurate use of the English language as well as a very thorough understanding by the writer of his subject. I sometimes wonder whether security and jealousy of patent rights have tended to make electronic specialists lose the habit of thinking in terms of public interest. I personally suffered that way in relation to the development of radar systems."

One or two points mentioned in Sir Raymund's speech have a much wider application than in the radio, television and electronics field. There is a reference to good and not-so-good articles. It is a distressing feature of a number of articles submitted at these offices that the technical quality is excellent, but the presentation poor and the English worse. One does, of course, edit, where necessary, to bring an article to accepted standards, but one cannot do much to a contribution that needs re-writing in any case. One might, with reference to our own industry, amend the words quoted at the beginning of this Commentary to read: "articles which are likely to enhance the reputation of the British instrument industry". Quality is a factor on which we pride ourselves in this country, and technical articles enter into the situation as much as products. Where the author is writing as a member of a particular concern it is essential for the prestige of that concern that the best possible contribution is written. Submitting an article in the draft stage to one or more colleagues for criticism for presentation, etc., is beneficial. Many times this is done, but not in enough cases. Where this is not possible, it might be advantageous to study papers or articles published by an independent body. With regard to the instrument industry one has, of course, the Society of Instrument Technology in mind. The papers in the Transactions of that body are of a very high quality and cover a wide variety of instrumentation. In particular, the examination of the paper that wins the annual Bowen prize might well reward a potential author.

Another point raised in the Director's speech was the reference to dissemination of information in the form of articles. Security reasons one must respect, of course, and one would not expect a large output from, say, the Atomic Weapons Research Establishment. The same degree of state security cannot apply, however, to some of our biggest instrument users. The number of articles published by any journal is disappointingly small. Could one plead for some relaxation here as there must be in these concerns many examples of instrument application which could, to requote a sentence above: "enhance the reputation of the British instrument industry".

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MAXIMUM RATINGS							
Peak Inverse Voltage at −65°C to +150°C	PIV	200V	600V	200V	600V	200V	600V
Average Rectified Forward Current at +50°C	I_o	750mA	750mA	† 400mA	† 400mA	*3A	*3A
Average Rectified Forward Current at +150°C	I_o	250mA	250mA	150mA	150mA	*1A	*1A
Recurrent Peak Forward Current at +50°C	i_f	† 2·5A	† 2·5A	† 1·25A	† 1·25A	*10A	*10A
Surge Current for 10 Milliseconds	I_{PK}	16A	16A	6A	6A	33A	33A
Operating Temperature, Ambient	T_A	—65°C to +150°C					
SPECIFICATIONS							
Minimum Breakdown Voltage at +150°C	V_z	240V	720V	240V	720V	240V	720V
Maximum Reverse Current at P.I.V. at +25°C	I_{Rb}	10μA	10μA	0·2μA	0·2μA	10μA	10μA
Maximum Forward Voltage Drop at +25°C	E_b	1·0V (I_o=500mA)	1·0V	1·0V (I_o=400mA)	1·0V	1·1V (I_b 1Amp)	1·1V

* Rectifier mounted on 2" x 2" x $\frac{1}{16}$" aluminium Heat Sink † @ 25°C

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T31

THE ROBOTUG

E.M.I. Driverless Trolley System

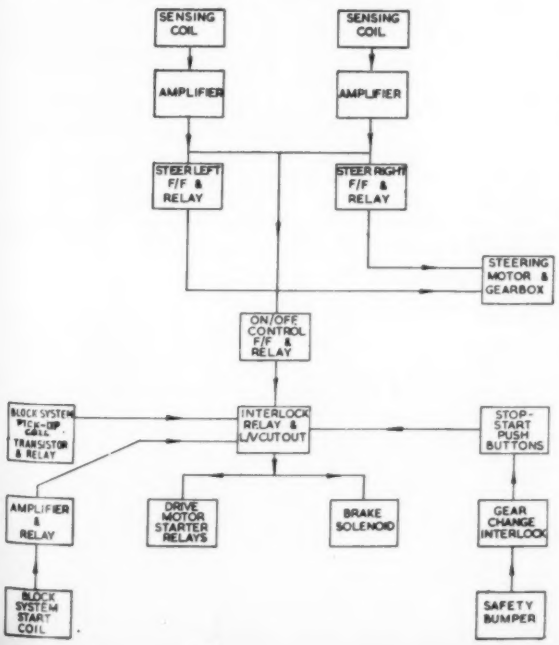
Control of the Trolley

THE basic E.M.I. electronic guidance system operates by making the trolley follow a single wire which is either taped to the surface for temporary routes or laid just beneath the flooring if it is to be permanent, having an alternating current about ½ amp of a specified frequency passed through it.

Due to the magnetic field produced around the wire a voltage will be induced in two sensing coils fixed to the front of the vehicle. As shown in the block diagram (Fig. 1) this small voltage is amplified by a two-stage transistor amplifier, suitably temperature compensated, and the resulting voltage is rectified and used to energise a bi-stable flip-flop operating a relay. These "Steer left or right" relays are used to control the steering motor, which is connected to the front wheel via suitable reduction gearing.

As long as the trolley remains on its correct course the voltage induced into either of the two sensing coils is low and the steering control is not operated. Should it deviate from its intended course, one or other of the coils will approach the wire, the voltage induced will increase, and at a predetermined point will be sufficient, via the circuits previously outlined, to operate the steering motor and turn the vehicle back on course. When the vehicle is on course, i.e., with both coils equally spaced either side of the wire, the steering motor will be switched off.

Fig. 1. *Schematic of trolley control system*



From the two amplifiers a further signal is derived which is the sum of the two signals and connected to a third flip-flop and an on/off control relay. This circuit is designed so that with the correct current flowing in the wire the relay will operate, release the brakes and energise the main drive motor starter relays. Thus if the current in the wire fails or the vehicle loses its course, the starter relays will be de-energised and the brakes applied. (See Safety Precautions.)

A comprehensive safety interlock system is provided. In series with the contacts of the on/off control relay are the contacts of the low voltage cut-out and interlock relay. This relay will only operate if the following conditions hold.

(a) Battery voltage above 21·5 volts
(b) Safety bumper micro-switches closed
(c) Gear lever in neutral or appropriate forward speed
(d) "Start" button has been depressed.

If any of the above conditions do not apply the vehicle cannot be started, or if it is running the drive motor will be de-energised and the brakes will be applied. This interlock relay is supplied with a "Self hold" contact so that if conditions (a) to (c) above apply, then, on depressing the "Start" button, the relay energises and holds, and providing current is flowing in the guide wire the vehicle will run. A "Stop" button is also provided on the machine which when depressed will de-energise the interlock relay and thus stop the vehicle.

Fitted to the front of the vehicle is a safety bumper so designed that if an obstruction is met a micro-switch will open-circuit, de-energise the interlock relay and halt the trolley. The vehicle then has to be manually re-started by pushing the "Start" button after the obstruction has been removed.

Block Control and Routing System

For controlling a number of trolleys on a variety of routes the track is first divided into a number of sections or "blocks". The track is normally de-energised

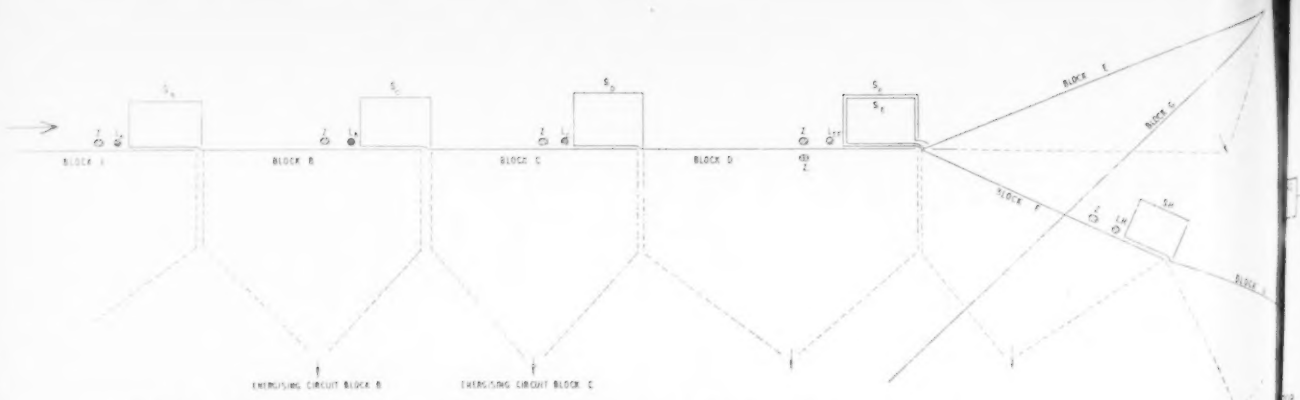


Fig. 2. Block control system

or "dead" and to operate the system only the section of the track over which the vehicle is passing or about to pass will be energised and further an unenergised or "dead block" will always exist between each vehicle and any other vehicle.

Starting the system will be described later but referring to Fig. 2, if it is assumed that block A is energised and a trolley is proceeding in the direction of the arrow, then eventually it will reach the first magnetic pick-up coil Z. Each trolley carries an oscillator feeding into a transmission coil, so placed on the trolley that it passes over the pick-up coil Z. When this occurs a voltage will be induced in coil Z, producing a pulse which is used to operate a sensing relay RLSB (See Fig. 3). This self holds via RLSB1. In order to proceed into block B, block C must be de-energised and therefore no trolley must be on that section. If this condition exists then RLC4 will be closed allowing RLB to operate via RLSB2 and self holding via RLB1. As RLB operates RLSB will be de-energised via RLB2, RLB3 will close energising block B, and RLB4 will open circuit de-energising RLA and thus block A.

Consider the case now when block C has a trolley in it and is thus energised. RLC4 will be open circuited and although RLSB will energise and self-hold as before, storing the information that a vehicle is waiting to pass into block B, RLB cannot operate and thus block B will remain de-energised. Since RLB is de-energised the track loop L_A will be energised. This loop is set in the floor so that as the trolley passes over it, a relay in the trolley will operate via a pick-up coil and this relay will halt the trolley via the interlock relay (Fig. 1).

Therefore it can be seen that if block C is clear (RLC4 closed) then block B will be energised and the vehicle will proceed, but if block C is occupied (RLC4 open) the vehicle will be halted by the track loop L_A.

It is physically arranged that if the vehicle is stopped by the loop L_A then it will stop in a position enclosed by the loop S_B in block A. Now since RLSB is energised (see Fig. 3), as soon as block C becomes clear RLC4 will close thus energising block B. The loop S_B is an extension of block B and is arranged, as can be seen from Fig. 2, in such a way that the side of this loop parallel to the main track is lying under a further "start" coil on the trolley. As block B becomes energised this coil will have a voltage induced in it, which suitably amplified will operate a relay, thus re-energising the interlock relay (see Fig. 1) and setting the vehicle in motion.

It will be noted that when the trolley is automatically brought to a halt in any particular block, the track current in that block still continues and is automatically overlapped by the track current from the block ahead via the starting loop S. Thus when the signal is given for the trolley to proceed, by block B becoming energised and block A automatically switching off, at no time do the sensing coils lose their input and therefore steering control is never lost.

Referring again to Fig. 2, supposing it is desired to send the trolley along block F and that it is approaching the end of block C. As can be seen from Fig. 4 providing RLE4 and RLF4 are closed, i.e., no trolley is in either of these sections then RLD can be energised and the vehicle is able to proceed along block D.

Suppose now two transmission coils are provided, one at each side of the truck which can be connected to the trolley oscillator at will (explained later under the heading "Destination and Route Selection Control System"). If the oscillator is connected to the transmission coil which passes over Z_1 (Fig. 2), then a pulse will be produced which will operate RLSF (Fig. 5). RLF will then energise, providing RLH4 and RLG6 are closed (i.e., block H and block G are not energised), and the vehicle will proceed along block F.

It can be seen that if other tracks join or cross a particular block further inhibiting contacts can be provided in the block energising relays. As these other tracks all become clear the relay will energise the particular block via the sensing relay contacts.

Starting the System

To start a vehicle on the system all that is required is to drive manually over the beginning of a given section with the oscillator on the trolley functioning (a push button being provided for this purpose) so that the particular block will energise as outlined previously. The vehicle may then be set to "Automatic" and started in the normal fashion.

Safety Precautions

Consider now the case if a trolley breaks down anywhere in the system. If it were travelling along a section, that section would remain energised in the absence of a clearing signal, since the trolley has failed to pass into the next block. Therefore other trolleys cannot approach closer than one "dead block" away.

If a "stop" loop fails then the trolley will still fail

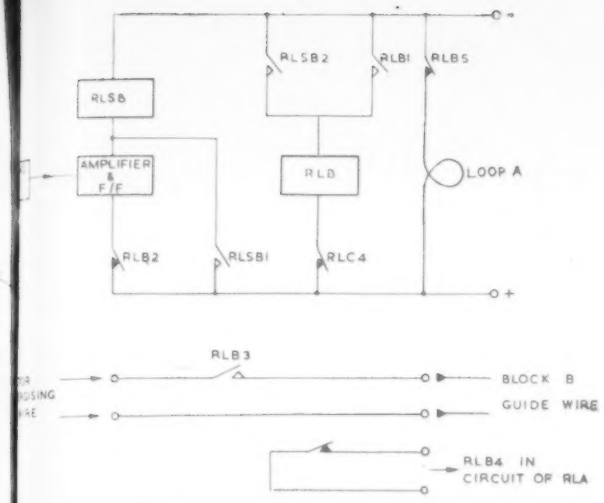


Fig. 3. Circuit 1 of block system

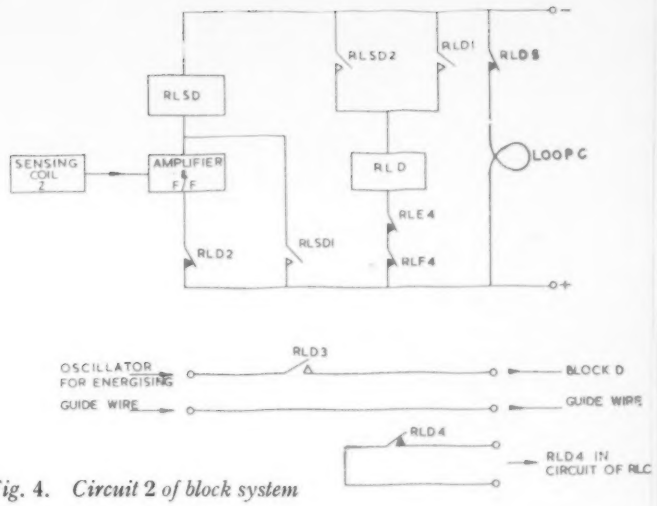


Fig. 4. Circuit 2 of block system

safe as instead of stopping within the loop S it will proceed to the end of the section since the next block is unenergised. The first condition mentioned in the preceding paragraph will then apply.

Supposing that the trolley fails to induce a pulse into the magnetic pick-up coil Z. (The oscillator fails for instance.) As far as the system is concerned the vehicle will have failed to energise the "sensing" relay and therefore the next section will remain dead. The stop loop will then bring the trolley to a halt. The section in which it then stands is still energised and further vehicles cannot approach more than one "dead" block away.

Summing up, it can be seen that any number of vehicles can now safely be run over a complex routing system. The criterion for the number of blocks or sections employed will be the number of branches and inter-sections envisaged and the amount of traffic passing down a particular route. The maximum number of vehicles which can be run on a particular system is half the number of blocks minus one.

The problem of ensuring that a given vehicle reaches its correct destination will now be considered.

Destination and Route Selection Control System

At certain points on the track such as where the track diverges further loops L_1, L_2, etc., are indicated (Fig. 6). These are fixed in the floor and are energised when an appropriate block is energised. A further pick-up coil and relay on the trolley operates a counting mechanism as each loop is passed.

It will be remembered that two transmission coils are provided on the vehicle which can be connected to the oscillator on the trolley at will, so that the trolley can be made to energise either the left or right fork at an intersection.

The "Programme Unit" consists of the counting mechanism mentioned and a "Coding" switch, so that if an operator has set in a given code then at appropriate points en route the oscillator will be connected either to the right or left hand transmission coil. Thus the vehicle can be made to pursue the desired course. Also contained in the code will be the point at which it

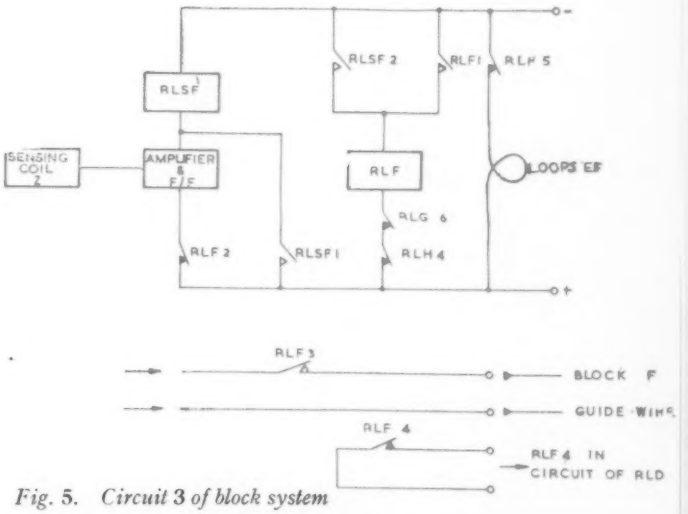


Fig. 5. Circuit 3 of block system

is desired to stop. The counting mechanism will then energise a relay which, in conjunction with the interlock relay (Fig. 1) will stop the trolley.

Referring to Fig. 6. Suppose it is desired to send a trolley from the loading bay to store D. Then the code for this would be Ba, and this would be set on the trolley by operating a multi-position switch and pushing a button so that the information is stored in the programme unit. On reaching L_1 the appropriate transmission coil on the trolley would be energised so that the trolley turned right at the first turn, and at L_4 the transmission would be connected so that the left-hand turn was taken. On reaching L_5 the stop circuit would be energised.

Having reached the desired destination the counting mechanism will have returned to zero automatically and the trolley can either be re-coded or returned to its point of storage or circulation.

Should any or all of the counting loops fail then the system will still be "safe"; the only thing which can occur is that a truck may reach the wrong destination.

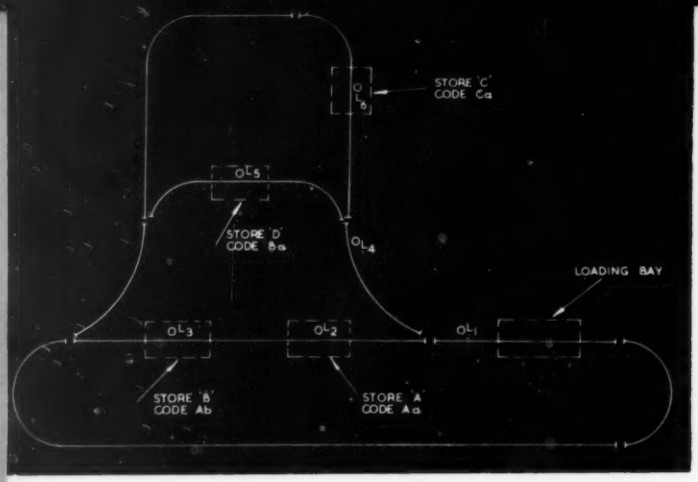


Fig. 6. Programme system

This is a simple Route Selection Unit. A complex one is available in which up to 12 or more "stopping" points can be stored and the trolley made to complete a number of calls before returning to its starting point.

Conclusion

From the foregoing it can be seen that numbers of trolleys can be run safely over extremely complicated routes, each trolley carrying its own programme unit so that it finds its correct destination. The system itself is inherently safe, in that any fault which may occur either in the trolleys or the control system results in the stopping of the trolleys or a particular section until the fault is cleared.

Control of Other Traffic

In a busy congested area where other manually controlled traffic is present, the demand may arise for the control of traffic lights, illuminated warning notices, hooters, etc.

Referring again to Figs. 2 and 3, it can be seen that the approach of a trolley can be determined by the energisation of the various block relays. It is therefore a simple matter to control other traffic which may be required to cross the trolley course by operating traffic lights. Further, the trolley may be inhibited by other traffic if it is desired to give this precedence over the trolley.

In a similar fashion conveyor systems, barriers, solenoid-operated doors, etc., can be controlled, or have control of the trolley.

STANDARDISATION OF VARIABLE-AREA FLOW METER SCALING

EIGHT types of standard glass tube flowrators which between them accommodate a wide range coverage of high medium and low flows are now being put on the market by Fischer and Porter Limited to meet the demand for flow meters on quick delivery. These instruments have percentage scaled metering tubes and are supplied with either a factor tag or a clip-in metal scale to convert the percentage readings to flow values in the user's required readings. They are adaptable to the vast majority of flow metering applications and, being entirely built from standard interchangeable parts which are available separately, will facilitate easy range changing.

It has been proved that the flow characteristics of all the Fischer and Porter bead guided metering tubes can be defined by one master calibration curve. This curve (Fig. 1) shows the distance a float will travel in any bead guided tube when the flow through it changes by a given fraction of the stated maximum flow for the particular tube and float combination.

To provide maximum flexibility three basic schemes have been designed which though varying in their degree of standardisation still remain within the definition of the term. The master curve has provided a calibration from which standardised scales have been produced. These are true scales which give a guaranteed accuracy of $\pm 2\%$ of maximum flow.

Percentage Scale Stock System

This system has made it possible to stock a complete range of instruments covering the range of maximum flows from 12 gal/h to 2,100 gal/h of water. The tubes used in these stock instruments are standard 10 in. bead guided tubes, calibrated from the master curve and scaled in actual flow units of 10-100% full scale flow. The floats used are pre-manufactured to a standard weight. Only four standard floats for each tube size are used and these have been designed to give full coverage of the flow ranges stated with reasonable range increments. When an order is received for this type of instrument, the nearest stock flow range is selected which will cover the maximum flow being metered, and a scale multiplying factor is calculated for the fluid stated. The flow passing through the meter is then readily determined by multiplying the scale reading by this factor.

The major advantages of this system are:—

(1) The instrument is a completely standardised meter and is available for delivery from stock.
(2) The standardised tube is pre-calibrated and available for delivery from stock when replacements are required.
(3) The standardised float is also available for delivery from stock when replacements are required.
(4) Tubes and floats are interchangeable within the

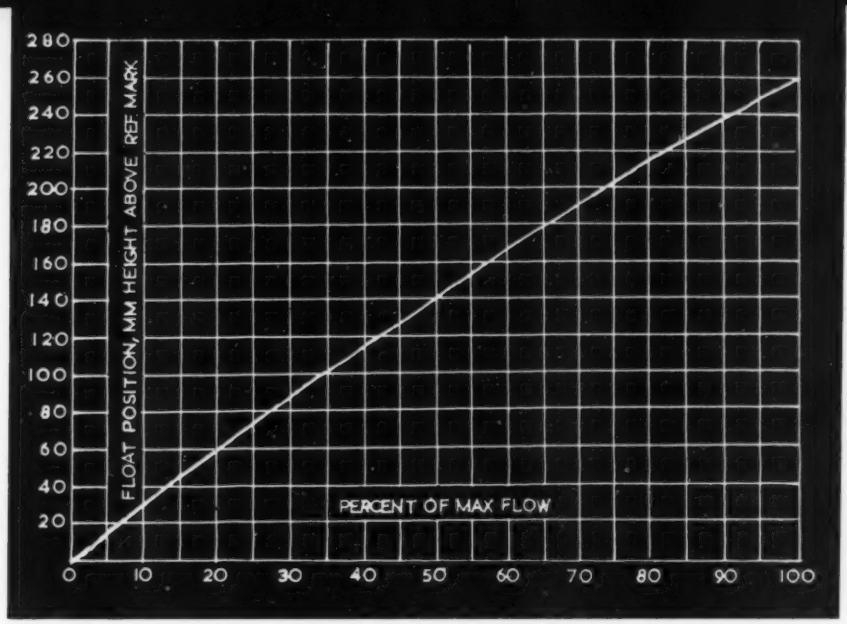


Fig. 1.
Master calibration curve

same meter size.

(5) The instrument still has a true flow scale.

Standard Scale Quick Delivery System

This system has made it possible to supply instruments on quick delivery, having a standard percentage scale tube, but in addition having a metal scale attached marked with the direct scaling of the particular fluid flow range being metered. The tube used in the standard range of instruments is identical to the tube used in the stock range meter. The float however is now designed to give a full scale flow reading equal to the maximum flow desired to be metered. When an order is received for this type of instrument, the nearest size of a standard bead guided metering tube is selected, and a suitable float is designed to give full scale reading for the maximum flow stated. A metal scale is then produced which is scaled in actual flow units of the fluid and range being metered. This system can only be offered when a preferred scale is chosen from the table in Fig. 2.

The major advantages of this system are:—

(1) The instrument is a standard meter with the exception of the float.

(2) The standardised tube is pre-calibrated and is available from stock when a replacement is required.

(3) The instrument has a direct reading metal scale as well as the true flow percentage scale on the tube itself.

(4) The metal scale is standardised, and available from stock whenever a replacement or a re-range is required.

Direct Reading Scale Normal Delivery System

This system has enabled Fischer and Porter to manufacture instruments using preferred ceramic transfer scales which are based on the master calibration curve. The use of preferred ceramic transfer standard scales still achieves a good degree of standardisation whilst permitting an instrument to be manufactured with a direct flow scale on the metering tube itself. When an order is received for this type of instrument, the nearest preferred standard scaled tube is chosen which will cover the range and fluid being metered. The float is then individually designed to give a maximum reading equal to the full scale flow being metered.

The major advantages of this system are:—

(1) The use of preferred scales employing ceramic transfers permits quick delivery when replacements are required.

(2) The printed ceramic scales have a very clear definition and provide a more durable type of printing.

(3) A second scale can be added to the instrument graduated for a different fluid density.

Low Flow Instrument Using Tri-flat Tubes

The Fischer and Porter range of low flow instruments use only patented Tri-flat metering tubes. The tube has a 5 in. scale length and the purpose of the three flats is to act as a guide for the precision ball metering float. This combination of the Tri-flat and precision ball float permits full prediction of the meter calibration to a guaranteed accuracy of $\pm 2\%$ over a maximum flow range from 25 cm³/min to 27,600 cm³/min of air at s.t.p. The only tube constant used in the calculation is the ratio of the tube diameter to the float diameter at any particular point of the taper, Dt/Df. Therefore a

Fig. 2. *Standard scales* 5 *in. and* 10 *in.*

Range	No. of Divisions		Units per Div.		No. of maj. Div.		Figures	
	10 in.	5 in.	10 in.	5 in.	10 in.	5 in.	10 in.	5 in.
1-10	50	50	0·2	0·2	10	10	2, 4, 6 etc.	2, 4, 6 etc.
1-12	60	24	0·2	0·5	12	12	2, 4, 6 etc.	2, 4, 6 etc.
1·4-15	75	30	0·2	0·5	15	15	2, 4, 6 etc.	2, 4, 6 etc.
1·6-17·5	87·5	35	0·2	0·5	17·5	17·5	2, 4, 6 etc.	4, 8, 12 etc.
2-20	100	40	0·2	0·5	20	20	2, 4, 6 etc.	5, 10, 15 etc.
2-20	50	50	0·5	0·5	25	25	5, 10, 15 etc.	5, 10, 15 etc.
3-30	60	30	0·5	1	30	6	5, 10, 15 etc.	5, 10, 15 etc.
3·5-35	70	35	0·5	1	35	7	5, 10, 15 etc.	5, 10, 15 etc.
4·0-40	80	40	0·5	1	40	8	5, 10, 15 etc.	10, 20, 30 etc.
4·5-45	90	45	0·5	1	45	9	5, 10, 15 etc.	10, 20, 30 etc.
5-50	50	50	1·0	1	10	10	10, 20, 30 etc.	10, 20, 30 etc.
6-60	60	30	1	2	12	6	10, 20, 30 etc.	10, 20, 30 etc.
7-70	70	35	1	2	14	7	10, 20, 30 etc.	10, 20, 30 etc.
8-80	80	40	1	2	16	8	10, 20, 30 etc.	20, 40, 60 etc.
9-90	90	45	1	2	18	9	10, 20, 30 etc.	20, 40, 60 etc.
10-100	100	50	1	2	20	10	10, 20, 30 etc.	20, 40, 60 etc.
0-250	125	—	2	—	25	—	0, 2, 4 etc.	—
0-130	—	65	—	2	—	13	—	0, 2, 4 etc.

tube calibrated in Dt/Df values becomes a standard scaled tube. By the use of the Fischer and Porter Tri-flat handbook the calibration of this standard scale can be calculated for a wide range of fluids, using the same or different densities of precision ball floats. Where the 2700 Model instrument is being used, a directly calibrated metal scale can also be supplied which would be scaled for the range of fluid specified.

The major advantages of Dt/Df scaling are:—

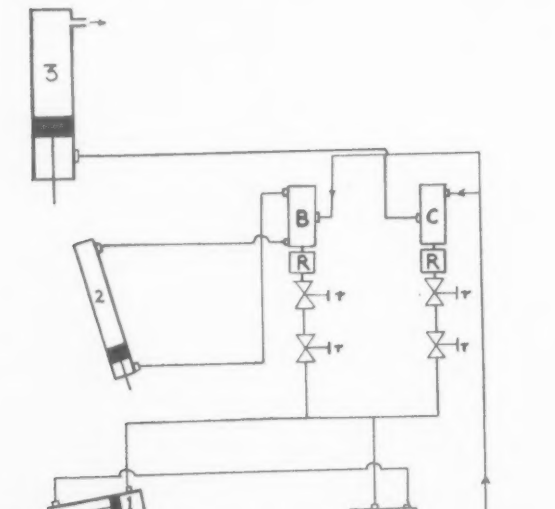
(1) Complete flexibility is offered when using the meter over a range of fluids.
(2) Customer can recalculate the scale if the actual fluid conditions differ from the designed conditions.
(3) The tube is a standard ceramic transferred tube and is readily available from stock when replacements are required.
(4) Direct calibrated metal scales can be supplied on the 2700 series instrument.

ELECTRO-PNEUMATIC SEQUENCE CONTROL EQUIPMENT

In the January 1959 issue, pages 43-47, some aspects of the automation systems operating at the Luton works of Vauxhall Motors Ltd. were described. Further information is now available which amplifies the article, particularly with regard to the cam-operated switches.

The Press Extraction System

ALL medium and heavy presses up to 1,500 tons are fitted with automatic jaw type extractors. These latter are virtually constructed in two sections: the carrying arm and the jaw member. The system incorporates power cylinders and valves which cause the carrying arm and jaw member to move in the required directions. Extraction is controlled by an electro-pneumatic signalling system, the sequence being started by means of a rotary, cam-operated, multi-switch driven by gearing in synchronisation with the eccentric shaft of the press.



Basic pneumatic circuit for the press extraction system

The extractors are mounted at the rear of the presses and move forward to grasp a pressing and lift it clear of the die immediately the press ram moves upward. The swinging arm, which supports the jaw unit, is then moved outward from the press and at the completion of its stroke the jaw opens to release the pressing on to a conveyor or turnover machine. The arm is then returned to its original position.

The actual equipment for each extractor unit comprises three double-acting air cylinders, a solenoid valve and two air-controlled valves, two bleed reservoirs for timing purposes together with two restrictor needle valves for each reservoir, and two micro-switches. One micro-switch is operated by the rotary cam switch mounted to the press, and the other is mounted to the jaw unit and determines the point when the jaw releases the pressing.

Operation of the Extraction System

Consider one cycle of operation.

At the beginning of the cycle the arm is in the resting position and the jaw is open. As the press ram moves upwards on completing a pressing, the rotary cam-operated micro-switch closes an electrical circuit causing solenoid valve A to be energised. The valve member moves and air passes to jaw unit cylinder 1 causing the piston to move forward. At the same time, air passes through the forward acting restrictor valve (r) into the reservoir (R). These form resistance-capacity units, and their purpose is to effect a short delay in the pressure build up for the operation of valves B and C. The delays are varied between 0 and 7 seconds by adjusting the restrictor valves. Following this delay, air passes to the bottom of cylinders 2 and 3. Cylinder 2 raises the jaw unit and the pressing it holds clear of the die while cylinder 3 operates causing the arm to move outwards from the press. During the outward stroke of the arm a second micro-switch is tripped which de-energises the solenoid valve A. The

resulting movement of the valve member allows air to pass to the front of jaw unit cylinder 1. Cylinder 1 piston retracts and thereby opens the jaw and releases the pressing at the predetermined point. De-energising of solenoid valve A also causes, after a time delay, the valve members of valves B and C to move causing cylinders 2 and 3 to return the arm and jaw unit to the resting position. The slow escape of air through the reverse restrictor valves ensures gentle return movement of the arm.

Adhesion Breaking Ejection

The second type of pneumatic control equipment used in the press shop, though smaller and less complicated in design than the jaw type extractor, is none the less of great importance.

At the completion of a press stroke there is considerable adhesion between the surfaces of the pressing and the lower die caused by the pressures exerted by the press rams. This adhesion must be broken so that the pressing may easily be removed from the press by the extractor. Ejection is achieved by means of air cylinders which are built into the lower die and which operate when the rotary cam multi-switch has caused a solenoid valve to be energised. Air passes to the bottom of the ejector cylinders causing the pistons to rise. Before the next steel sheet or pressing is loaded on to the lower die the rotary cam switch again operates and de-energises the solenoid valve. This allows air to pass to the top of the ejector cylinders causing the pistons to return to their original position.

Side-lancing Operations

The side-lancing of a pressing presents a problem because the use of complicated dies often results in angled die surfaces which are opposed to the thrust direction of the press rams. This means that side-lancing of, say, an inner door panel or inner boot lid cannot be carried out in the normal manner by the standard mechanism, within the press, but has to pass through, say, four more presses, each angled side having to be presented horizontally to the press rams. This could be a very costly process involving the casting and proving of up to four additional sets of dies and the use of four presses in a press line purely for lancing operations.

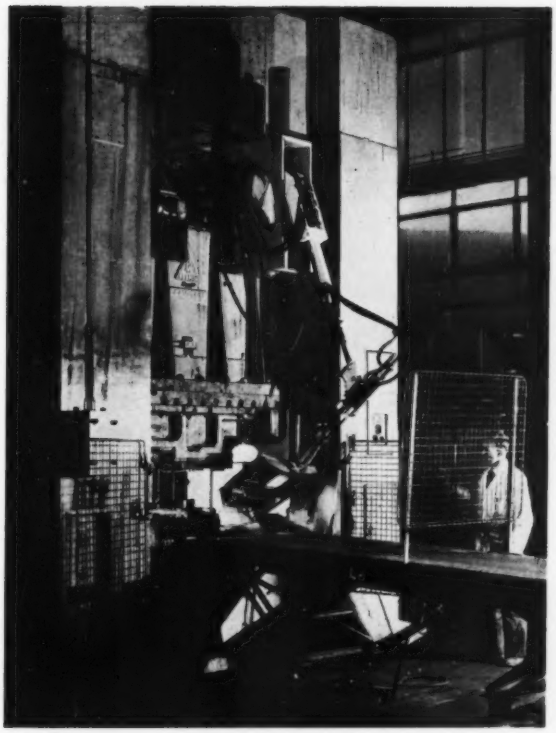
The problem has been effectively and successfully overcome by the use of built-in air cylinders which carry lancing punches at the ends of the cylinder pistons and which are mounted within the dies at 90° angles to the surfaces to be lanced. This means that a single press can carry out side-lancing operations while a pressing is being formed, and at a resultant saving in cost, etc.

The side-lancing punch cylinders operate when the press rams come together and are controlled by the rotary cam multi-switch in the press and a solenoid valve in the manner described for ejecting operations.

Loading Machines

The most commonly used loading machine is the standard portable shuttle loader which passes steel sheets or pressings into the press in continuous cycles.

Each shuttle loader operates by the use of two double-acting air cylinders, a solenoid valve, two roller-actuated valves and an air-operated valve. The solenoid



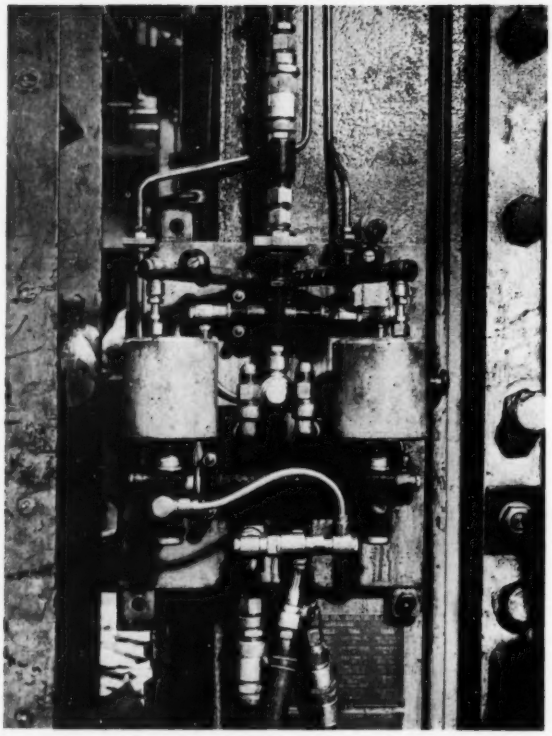
Press extraction system in operation

valve is energised by the rotary cam switch and air passes to a cylinder which lifts the shuttle carriage vertically at the commencement of a cycle. The shuttle, when lifted to receive a steel sheet or pressing, actuates a roller valve which causes the second cylinder to move the shuttle carriage forward horizontally to the press orifice and load the pressing or sheet on to the die. At this point the rotary cam switch again operates de-energising the solenoid valve. This causes the shuttle raising cylinder to retract and lower the shuttle. At the end of this stroke the second roller valve is actuated, causing the shuttle carriage cylinder to retract and return the carriage horizontally to its original position. This completes one cycle. The press then forms a pressing and at a predetermined point the rotary switch operates and energises the solenoid valve which starts a second loading cycle.

Pre-bending Machines

The use of portable pre-bending and loading machines has greatly assisted production and removed complicated die operations.

In the production of a pressing, such as a car facia panel which has a "U" section, the sheet steel has to be first bent to the appropriate shape before being fed into the press, to prevent cracks and draw lines appearing in the metal as a result of the pressure. This problem has been successfully solved by the pre-bend loader which uses power cylinders and valves. An example of one type of pre-bend machine in use is described below.



Reservoirs and restriction valves

A steel sheet is fed by hand on to the loader platform and passes, in synchronisation with the press stroke, between two sets of lateral roller bars. Depending on the shape required and the amount of angle or curve to be given to the steel sheet, the bars are correctly positioned and the distance the top bars descend is appropriately adjusted. At a selected point the top roller bar descends on to the steel sheet by means of air cylinders and forces the sheet between the two lower bars. If a flat overlap is required, two additional top bars descend which level off the protruding metal each side of the bent section. The formed sheet is then lifted by air cylinders and a small air cylinder controlled clamp grips the metal. When the press reaches the end of its stroke and the dies are apart the clamp and carriage move the shaped steel sheet into the press. The sheet is placed in position on the lower die and the carriage then returns to start a second operation.

The loader platform carries three steel sheets at a time and the operation is continuous with the operation of the press. The air cylinders which actuate the platform, roller bending bars and jaw unit are controlled by valves and bleed reservoir units. The complete machine is controlled by the rotary cam micro-switch in the press which actuates a solenoid valve allowing air to pass in correct sequence to the various cylinders and valves, etc.

Turnover Machines

The production of a complicated pressing often requires that the pressing has to be formed from both sides. Thus, at some stage or stages in production the pressing must be turned over before it is fed into the next press.

To replace manual turnover operation a portable turnover machine has been developed which can turn over pressings of many sizes and feed them directly into the next press. This machine contains power cylinders and valves and comprises a wheeled-base trolley which has a vee-shaped slide in the direction of travel between presses. A normal jaw type extractor extracts a pressing and places it at the top of the slide nearest the press. The pressing moves down the slide and in its resting position is standing vertically on its edge. A cylinder piston then pushes the pressing over "top" downwards on the opposed slide and other air cylinders operate and push the pressing up this slide and into the next press. This operation is continuous with the operation of the press and is controlled in the usual manner by the rotary cam multi-switch on the press actuating a solenoid valve. Timing reservoirs control the operating sequence and timing of the separate movements of the cylinders and valves, etc., and the "start" and "stop" sequence is controlled by the rotary cam switch.

All the pneumatic control units are manufactured by Maxam Power Ltd., one of the companies of the Holman Group.

BOOK REVIEW

Handbook of Automation, Computation and Control. Volume I. Control Fundamentals

Edited by Eugene M. Grabbe, Simon Ramo and Dean E. Wooldridge. John Wiley and Sons Inc., New York; Chapman and Hall, Ltd., London, 1958. 990 pages. 136/-.

This volume, dealing with General Mathematics, Numerical Analysis, Operations Research, Information Theory and Transmission, and Feedback Control, must be regarded primarily as a reference book; for it skims over the subject matter and gives few explanations for its statements.

It is superficial because it summarises a great deal in very short space, but it assumes the reader will either have or will wish to acquire a vast background of knowledge in order to understand it. The inclusion of comprehensive bibliographies at the end of each chapter, and an excellent index, make it a very useful volume, within its accepted limitations.

The volume is one of a set; the second volume dealing with Computers and Data Processing and the third with Systems and Components. As the publications are of American origin, it remains to be seen how useful these other publications are likely to be to readers in Britain.

The particular volume under review is likely to be of use to engineers, but could, as part of a complete set, be useful to have on the library shelf of the business man, who either intends to use, or uses, computers, provided the next two volumes measure up to expectation.

R. H. WILLIAMS

The Presidential Address to The Society of Instrument Technology, 6th May, 1959

The Education of Instrument Technologists and Control Engineers

By J. F. COALES, O.B.E., M.A., M.I.E.E., F.Inst.P.

1. Introduction

THE last thirty years have seen a very large change in the pattern of industrial employment. Not only have there been enormous technical developments, but also there has been a great increase of real wealth which has resulted in a demand for very large quantities of manufactured goods. This has resulted in the development of mass production methods followed by automatic production and other improved methods of manufacture generally known as automation. It has also resulted in a much greater awareness on the part of management of the need for research and development to provide new products and better ways of making them in order to remain competitive. As a result of the latter, the more advanced industries are already employing large numbers of professional engineers and scientists, in many firms more than a tenth of the total number employed. The introduction of mass production methods and automatic machines has led to the employment of fewer skilled craftsmen in some industries, but owing to the general expansion of industry, particularly in the manufacture of capital equipment, there has at present been no reduction in the total number of skilled craftsmen required. Thanks, however, to labour saving devices of one sort or another the heavy labour has been almost entirely eliminated from industry and the number of unskilled employees has been reduced. On the other hand the number of technicians required for supervising equipment, maintenance and carrying out routine tests has increased enormously.

2. Probable Future Requirements for Skilled Personnel

In America, statistics show that about 25% of the working population is employed in productive industry, the remainder being in professions, the armed services, banking and insurance, the distributive trades, etc. It is generally considered that automation is not applicable to all productive industry but, if the best use is to be made of automation, it must also be introduced in other industries such as mining, transport, banking, insurance, etc., which are not included in this 25%. Appendix I, taken from the Annual Abstract of Statistics, 1958, slightly rearranged, gives the number of employees in the various types of employment in Britain. It is seen that out of 24,000,000 employees, (20,000,000 full-time) 38% were employed in manufacturing industries, in all of which greater productivity can be expected from automation. In the second group, employing 5% of the total, automation is also playing a full part and increased productivity is entirely dependent on technological advance. The third group can also be affected to a limited extent, and in the last category "insurance, banking and finance" the application of office machinery is likely to be very important.

Thus it is seen that in Britain, industries employing about 50% of the working population, or approximately 12,000,000 people, are dependent on technological advance if Britain is to compete effectively in World markets with Germany, the U.S.A. and the U.S.S.R.

It is probable therefore that the best estimate that can be made is to assume that a large part of British industry needs to have 10% of its employees fully qualified technologists as soon as possible, and therefore that, of the 12,000,000 persons employed in industries dependent on technological advance, at least 5% of the fully employed, or 500,000, need to be qualified technologists now.

As the area in which automation is applied increases, so the numbers employed will inevitably change, so that when the industries have been modernised the total labour force employed will probably continue to be about 10,000,000, while the amount of goods produced will probably be doubled. The total unskilled, semi-skilled and skilled labour remaining may be expected to be about 6,000,000, while the number of technicians will no doubt have to increase to about 3,000,000 and the technologists to about 1,000,000. Since the output will have doubled,* this increase in the number of technologists may be considered reasonable.

Further, for economic reasons, as output increases the length of manufacturing runs will have to be increased and product development will become of greater importance, since it will be essential that, when sales of the current products dwindle, there are other acceptable products to take their place. Also, with much increased productivity, raw materials in America are already being used up at a dangerously high rate and in the future economy in the use of raw materials will be essential. Product design will therefore have to take this into account. For both these reasons the number of technologists required is likely to be greater.

It is extremely difficult to estimate what proportion

*—This only assumes a doubling of output by 50% of working population and may be taken to represent a 50% increase in standard of living which on a basis of 3% per annum should be achieved in 12 years. For comparison it may be noted Russia reckons that by 1960 production of consumer goods will have been increased three times from the 1950 level.

of the technologists and technicians will require to be trained in control engineering and instrument technology. In the U.S.A. there are estimated to be 40,000 control engineers, and it is probable, therefore, that there are at least 200,000 technicians; since the number employed in manufacturing industries in Britain is about half that in the U.S.A., it is probable that we need at least 20,000 control engineers and about 100,000 instrument technicians. On the basis of 36 years expected active life, this requires an annual output from our universities and colleges of at least 500 control engineers, and from our technical colleges 3,000 instrument technicians. Later it will be seen that there is a strong case for all engineers and the majority of technicians in industry having a good training in instrument technology.

3. The Need for Control Engineers and Instrument Technologists

As methods of production become more automatic, a wider range of techniques has to be employed for determining the quality of the product and for controlling the manufacturing plant. Thus whereas until the 1930s machine shops and most industrial plant were designed and could be maintained entirely by mechanical engineers, water wheels, steam engines and belt drives have now been largely replaced by electric motors and maintenance departments now have to include electrical engineers. The development of transfer machines has brought more electrics to the shop floor, sometimes in the form of limit switches and control circuits, but also in instruments, such as those measuring the torque on the cutting tool and for operating alarms when a tool needs to be replaced. Thus for the design of such plant, a team is required which includes not only mechanical and electrical engineers, but also instrument technologists and control engineers and probably other specialists such as metallurgists, paper technologists, etc. When the plant has been designed, built and installed it must be maintained by a staff which has experience of instrument technology and control as well as mechanical and electrical engineering. No matter what the product, you will always find automatic machines used somewhere in its manufacture; you will always find some instruments employed to measure its quality and you will always find some automatic control. In addition to the instruments on the plant, you will probably find electrical, mechanical or electronic office equipment and possibly a digital computer.

3.1 *Control Engineers*

It follows that though the young engineer may start in industry as either a mechanical, electrical or chemical engineer, as soon as he is in charge of a department he will need a working knowledge of at least two of these technologies and of control engineering and instrument technology as well. Similarly the engineer who is responsible for the development of the plant will need a team containing all these types of engineer and he must be able to co-ordinate their work. Thus the old categories of engineer are no more satisfactory divisions on the shop floor than in research and development.

For research and development, new categories of engineer, such as aeronautical, nuclear, communications and control are rapidly growing up and it does not matter to which branch a man is drawn, if he is to make his mark in any of these fields he will require very much the same mathematical technique and knowledge of classical physics. On the other hand if an engineer is going to enter the production side of industry, although he will not need to attain such a high level of mathematics, he will certainly need a very good grounding in the fundamentals of mechanical and electrical engineering, applied physics, instrument technology, control engineering, and sometimes chemical engineering as well. It therefore appears that in our engineering schools, instead of the students having to choose between civil, mechanical, electrical and chemical engineering at an early stage, they would be better divided into those with an aptitude for mathematics and research, who might be expected to enter industry on the research and development side, and those with a lesser aptitude for mathematics but probably better at dealing with practical problems, who would wish to enter industry on the production side. There should be no feeling that the production engineer is in any way inferior to the research engineer because both will have difficult problems to solve and who is to say that one type of problem is more exacting than another.

In his Presidential Address last year Sir Harold Hartley made a plea for the introduction of control engineering as a primary technology taught at undergraduate level.

There is much to be said for this because control engineering not only uses all the traditional engineering disciplines but also the newer techniques of quantitative dynamic analysis and systems design which are necessary if both functional efficiency and economic design are to be optimised. We have already seen that the production engineer must have a good fundamental training in mechanical, electrical and electronic engineering as well as applied physics and that for research and development in control engineering, the same advanced mathematics is required as in other fields of science. In addition the control engineer must be trained to consider a system as a whole, whether it be a chemical plant, a production line, an automatic office, a guided missile or a washing machine. He must be able to find out the physical properties of the fixed components of the system and to combine them with other components, which he may have to design himself, in order to obtain the best possible performance as a whole. In fact, he must be able to employ the techniques of control with a view to making the system an optimum, taking into account plant economics as well as physical performance. It is most fortunate that the mathematics and physical principles involved are similar, no matter whether the components of the system are electrical, mechanical, hydraulic, chemical or nuclear.

The early years of training must therefore be devoted to applied physics and mathematics with instruction in the methods of applying the principles to practical problems. Of course in the later years of training there must be some specialisation, but probably while undergraduate courses are of only three years duration, little more than fundamentals can be taught. However, if these have been properly assimilated, the graduate apprentice should have little difficulty in learning the

specialisation of the industry in which he finds himself. In sandwich courses, the fundamentals will, of course, be taught in the periods at college while their application to special problems should be learnt at the works.

Just as control engineering is an excellent training because it involves all branches of engineering, so also it is an excellent career because in practice it will take a man into all parts of the factory and possibly into a wide range of industries. In a team developing or designing new plant, the control engineer nowadays plays an essential part and while it is most desirable for all the specialists in the team to understand and appreciate what the others are doing, it is usually quite essential for the control engineer to do so, because control can only be effective, if the plant is considered as a whole. Thus the control engineer is always broadening his experience and provided he does not allow his specialist techniques to become rusty and also has qualities of leadership, his superiors are likely to single him out as the obvious choice to lead a development team or manage a department.

3.2 *Instrument technicians*

When we consider technicians, we are faced with a much more difficult problem because it is usually considered that technicians are only capable of acquiring knowledge over a fairly narrow field. In the maintenance departments of big factories and chemical plants, however, the technicians are responsible for and service a very wide range of instruments and equipment. In the highly automated industries, the broad category of technicians includes installation engineers, maintenance engineers, plant operators, charge hands, foremen, and test operators both for laboratory tests and quality control. While professional engineers, taking greater responsibility, are expected to show greater initiative and require a wider technical training at a higher intellectual level, technicians are expected to have a fairly wide technical training and to show more initiative than the craftsmen, who are only expected to have acquired specialised skills with their hands.

It has already been seen that the number of technicians required by manufacturing industry is likely to be between two and three million. It is probable therefore, that the majority will have to be drawn from the ranks of those who would previously have been craftsmen. At any rate it seems certain that there will not be sufficient young men and women educated in secondary grammar schools and at least a third will have to be drawn from the secondary modern schools. Now that the Diploma of Technology is to become the standard qualification for the professional technologist, the Ordinary and Higher National Certificates will presumably become the accepted qualifications for the technician but the way must be left open for the brighter technician, who has attained a Higher National Certificate, to proceed to a professional qualification.

4. Syllabi of Ordinary and Higher National Certificates

The difficulty in training control engineers and instrument technologists is that the field of application, and as a result the diversity of techniques employed, is so wide. Very little thought leads to the conclusion that there is hardly an industry or a human activity in which automatic control and measurement do not play a part. Most forms of transport and industry employ automatic control to a lesser or greater extent, while many operations in the home, and even the entertainment industry, sport and games have their quota.

Appendix II lists the most important quantities and some of the industries and activities, in which they have to be measured and controlled, and tabulates the methods that are used for measuring them under the headings, Mechanical, Electrical, Optical, Chemical and Other, together with types of amplifier and of sources of power, since all control systems must include these. Consideration of this table will make it clear that not only must the professional control engineer have a wide knowledge of the techniques of mechanical and electrical engineering and also of physics, but also the technicians must be trained in the fundamentals of these disciplines. Instrument technicians must also have some training in workshop practice and engineering drawing, and it is desirable therefore that they should reach the standard of the Ordinary National Certificate in both mechanical engineering and electrical engineering as well as in applied physics. At first sight, this appears quite unreasonable, but study of existing syllabi for these Ordinary National Certificates shows that all three are almost entirely applied physics. When it comes to the courses for the Higher National Certificate the situation is more complicated.

4.1 *Ordinary National Certificate in Instrument Technology*

In many of the more important industries the view has been held for several years that while the City and Guilds courses in instrument manufacture and maintenance are excellent for their intended purpose of training craftsmen, there are no suitable courses of Ordinary or Higher National Certificate standard in instrument technology for training technicians. It has also become clear that the instrument departments of the process industries, and almost certainly of many manufacturing industries as well, require a greater number of technicians than craftsmen for installation and maintenance on account of the very wide range of instruments that have to be installed and maintained by a small department. Enquiry shows that the instrument departments are succeeding in recruiting apprentices of sufficient calibre to take Ordinary and Higher National Certificates, but since there are no accredited Ordinary and Higher National Certificate courses in instrument technology the apprentices are having to attend courses in electrical or mechanical engineering or applied physics. Although certain of these courses have been tailored to meet the requirements of instrument technology to some extent while still being acceptable to the major institutions, examples being an Ordinary and Higher National Certificate course in mechanical engineering at Northampton College of Technology and a course in applied physics at the Liverpool College of Technology, these courses of necessity have to meet the requirements of the respective professional institutions and are not entirely satisfactory as courses in instrument technology.

In this connection it must be remembered that an apprentice, if he has sufficient initiative to be worthy

of the name, will always wish to attend a course that can lead, if he is successful, to a professional qualification, and so long as courses in instrument technology cannot lead, for the better students, to graduate membership of one or other of the professional institutions, the better apprentices will insist on taking courses in chemical, electrical or mechanical engineering or applied physics. It is therefore most important that any Ordinary or Higher National Course in instrument technology be acceptable as part-qualification for graduateship of at least one, and preferably all, of the major institutions if taken in conjunction with additional endorsement subjects.

The Education Committee of the Society of Instrument Technology has therefore considered the possibility of devising syllabi for Ordinary and Higher National Certificate courses, which, while meeting the needs of the instrument technician in the best possible way, are at the same time acceptable to the major institutions as part of the Ordinary and Higher National Certificate courses in electrical and mechanical engineering and applied physics. The syllabi for electrical and mechanical engineering and applied physics courses issued by a number of technical colleges have been studied, and for the Ordinary National Certificate the "lowest common multiple" has been written down under the headings Mathematics, Physics, Chemistry, Mechanics and Engineering Drawing, and has been supplemented by those additional items which are considered necessary for instrument technicians. As might be expected, the content was found to be too great to be covered in one day or three evenings a week for three years. It was considered most desirable that the course should be able to be covered in not more than three evenings a week, since it was appreciated that such a course was unlikely to satisfy the requirements of the major institutions entirely, and that the Institution of Mechanical Engineers for instance, would require more engineering drawing while the Institute of Physics would require a course in workshop practice. There being at the present time no accredited professional qualification in instrument technology, many students would no doubt wish to qualify for a mechanical engineering or applied physics National Certificate as well as one in instrument technology and might wish to do this by study on an additional evening each week. The syllabi for the Ordinary National Certificate have, therefore, been very carefully considered to see whether they cannot be arranged in a more logical manner with a view to economy in teaching time while retaining all the essential material. The result of these deliberations is given in Appendix III.

In many universities, the teaching of engineering at undergraduate level has, since the war, become much more fundamental and mostly applied physics. Similarly, in these syllabi, time has been saved by abandoning the traditional division of physics into heat, light, sound, electricity and magnetism which has resulted in similar phenomena being taught under several different headings. Instead it is proposed that the fundamental concepts be taught in a course entitled "Structure and Properties of Matter" which will include not only the physical phenomena observed in the fields of heat, light, sound, magnetism and electricity, but also radioactivity and those other essential parts of modern physics which do not fit into the traditional Physics syllabus in a tidy manner. It is believed that this course could be covered during the first year on one evening a week and would naturally lead on to a course entitled "Mechanics and Energy" in which wave motion and the transmission of different forms of energy could be treated in a co-ordinated and logical manner, thereby saving considerable time and toil. I am greatly indebted to my colleague, Dr. G. D. S. MacLellan, for preparing these syllabi which have now been considered and approved by the Education Committee. It will be seen that these two syllabi include almost all the general physics, heat, sound, light other than geometric optics, some of the electricity and magnetism and most of the chemistry required for the Ordinary National Certificates in physics, electrical engineering and mechanical engineering. If these two syllabi can be covered in the first two years of the course, this will leave geometric optics, electricity and magnetism and some chemistry to be covered in the third year. The mathematics syllabus has been re-arranged in an attempt to make it fit in with the physics course. I think everything is here that is necessary for engineers of any category, but certain items such as conic sections and radius and centre of curvature in connection with differentiation have been omitted as being no longer required. If the mathematics, physics and chemistry can be completed in two evenings a week, this leaves the third evening for engineering drawing, of which only one year is considered necessary for instrument technologists. The third evening in the second and third years would then be used for applied physics with particular reference to measurement and control, and it is hoped that this would include a fair amount of practical work. Thus the timetable would be expected to be as given in Appendix IV.

It is to be hoped that eventually we may have an Ordinary National Certificate which is common to all technologies, since there can be little doubt that it is the same mathematics, physics, chemistry and engineering drawing which is required by all, and it will almost certainly be found that a better understanding of the fundamental concepts of mathematics, physics and mechanics is more important than particular knowledge of a special technology. Until this desirable state of affairs has been achieved, it will no doubt be necessary for a fourth evening to be used for additional subjects. An attempt to indicate what is likely to satisfy the major institutions on the basis of existing syllabi is also shown in Appendix IV.

4.2 *The Higher National Certificate*

Although Northampton College of Technology succeeded in devising a Higher National Certificate in instrument technology which was acceptable to the Institution of Mechanical Engineers, the considered opinion of the Education Committee of the Society is that this has an insufficient content of applied physics, and that the course in applied physics of Liverpool Technical College is much nearer the requirement. The requirements for an ideal Higher National Certificate are, therefore, being carefully considered. The proposed syllabus is not yet agreed, but the expected timetable has been included with that for the Ordinary

National Certificate course in Appendix IV. The syllabus at present under consideration does not differ greatly from existing Higher National Certificate courses in applied physics, which is important since it is most desirable that it should satisfy the Institute of Physics as the major part of the requirement for graduateship. It would also be of very great advantage both to the student and to the nation if graduateship of the Electrical and Mechanical Engineers could be obtained by additional study without having to go over the same ground again. It is considered that it will not be possible to cover all the mathematics required by the instrument technologist in the A1 and A2 years and that some further training in advanced control theory and special measurement techniques will also be required. It is proposed that these should be taken as endorsement subjects in a post H.N.C. year together with a course in either industrial electronics or industrial management. It is suggested that the advanced course in measurement and control might be tailored to suit the type of industry predominant in the locality of the technical college.

5. Conclusion and Recommendations

At the present time there is no Joint Committee for such awards but the Ministry of Education is, with the Institute of Physics, planning Ordinary and Higher National Certificates in applied physics (instrumentation), which will be intended for instrument technicians. An announcement is expected soon and it is hoped that courses can begin in September this year. As an interim measure, this is excellent and these courses will undoubtedly go a very long way to giving instrument apprentices the education they require. It must be remembered, however, that instrument apprentices are usually in engineering departments and enquiry has shown that most of them want to work for an engineering qualification as well as one in physics.

It has also been seen that instrument technology includes the fundamentals of chemical, electrical and mechanical engineering as well as applied physics, and it is therefore considered that the Higher National Certificate in instrument technology should be able to be used as part of the qualification for graduateship of any of these Institutions. It is therefore considered that the approving committee should include representatives of the Institutions of Chemical, Electrical and Mechanical Engineering, The Institute of Physics and the Society of Instrument Technology.

It must not be thought that in putting forward new syllabi the Society expects them to be mandatory. The usual procedure for National Certificates is for the appropriate professional institution to propose syllabi as a guide to technical colleges in planning their courses, which courses have to be approved by the sponsoring committee. In any case, the proposed syllabi will mean a break with the traditional methods of teaching in many colleges and may be extremely difficult to implement with the existing organisation of departments. In view of this, the Society proposed to hold a two-day conference in September this year in order to discuss these syllabi and how they could be taught. To this conference representatives of the Ministry of Education, the major institutions, technical colleges and industry will be invited. How best to teach a technology is always a controversial subject, and so the Society will welcome comments and criticisms of the syllabi published herewith.

One of the most important conclusions resulting from discussions with apprentices and young engineers is that the majority of them wish to attend courses of instruction which give them the greatest freedom in choosing a career. For this reason many instrument apprentices choose electrical engineering rather than mechanical engineering, and few will do the City and Guilds' courses. If we are not to stifle initiative, we must ensure that there is a president's gavel in every apprentice's toolkit and that he does not have to return to base after completing part of the course in order to pick it up. There is little doubt that the intellectual calibre of the average apprentice is rising and there is an urgent need for a common Ordinary National Certificate which would enable the apprentice to delay his final decision on which professional qualification to choose until he was at least 18. If then the Higher National Certificates were arranged so that each would give some exemption from the qualification for graduateship of all the major institutions, we should be well on the way to avoiding square pegs in round holes. This in turn would lead, not only to a happier society but also would result in many of the better technicians developing to the stage of obtaining professional qualifications and swelling the ranks of the technologists, of which we are at present so short.

Appendix I

Estimated Numbers of Employees, 1957

	('000s)	
1. Manufacturing industries		
Treatment of non-metalliferous mining products other than coal	336	
Chemical and allied trades	534	
Metal manufacture	579	
Engineering, shipbuilding and electrical goods	2,136	
Vehicles	1,225	
Other metal goods	521	
Precision instruments, etc.	157	
Textiles	934	
Leather, leather goods, etc.	71	
Clothing	678	
Food, drink and tobacco	916	
Manufacture of wood and cork	311	
Paper and printing	583	
Other manufacturing industries	290	
		9,271
2. Other industries very dependent on automatic methods		
Mining and quarrying	868	
Gas, electricity and water supply	379	
		1,247
3. Industries partly affected		
Agriculture, forestry, fishing	1,025	
Transport and communication	1,723	
Distributive trades	2,945	
Insurance, banking and finance	509	
Building and contracting	1,519	
		7,721
4. Services almost entirely unaffected		
Public administration	1,298	
Professional services	1,896	
Miscellaneous services	1,812	
H.M. Forces and Women's Services	702	
		5,708
5. On release leave	8	
Unemployed	250	
		258
TOTAL		24,205

Appendix II

Some quantities that have to be measured and controlled and some of the industries and activities in which they are important.

Quantity to be measured	Methods	Main techniques employed					Industries in which important, and other uses
		Mechanical	Electrical	Optical	Chemical	Other	
Linear dimensions	Micrometer	X					Toolmaking and precision engineering. Transfer machines. Shipbuilding, boilermaking. Motor and aircraft manufacture. Thickness measurement in metal sheet and foilmaking, papermaking and plastics
	Dial and slip gauges	X					
	Stylus	X					
	Shadowgraph			X			
	α, γ and β-ray gauge					radioactivity	
	Ultrasonic	X	X				
	Pneumatic gauge	X				pneumatics	
	Microscope			X			
	Eddy currents		X				
Position or displacement (linear or angular)	Gearing	X					Defence and armaments. Airport control. Transport. Steel mills, mining, textiles. Automatic assembly
	Gyroscope	X					
	Resistance potentiometer		X				
	Inductive potentiometer		X				
	Electrostatic capacitance		X				
	Electrostatic transducer		X				
	Electromagnetic transducer		X				
	Photoelectric detector		X	X			
Velocity	Ball governor	X					Transport. Mining (winders). Steelmills (table and roll drives). Guided missiles. All types of automatic manufacturing plant in textiles, papermaking, bakeries, etc. Crane drives. Electricity supply
	Gyroscope	X					
	Tachogenerator		X				
	Doppler effect		X				
	Counting methods		X	X			
Acceleration	Pendulum	X					Guided missiles, aircraft. Packaging
	Resistance strain-gauge	X	X				
	Piezoelectric crystals		X				
Pressure	Bourdon tube	X					Chemicals, oil, gas and many food processing industries. Electricity supply. Shipping. Water supply
	Bellows	X					
	Liquid column	X					
	Resistance strain-gauge		X				
	Piezoelectric crystals		X				
	Other electrical and displacement detectors						
Liquid level	Floats with lever and chain combined with displacement detector (see above)	X	X				Chemicals, oil, most process industries. Industrial and ships' boilers. Domestic appliances
	Gamma-ray gauge					radiation	
Fluid flow	Positive displacement meters	X					Chemicals, oil, most process industries. Industrial and ships' boilers. Domestic appliances. Water supply
	Rotameter	X					
	Venturi	X					
	Ultrasonic flowmeter		X			ultrasonic	
	Aerofoil	X	X				
Temperature	Thermal expansion	X					Chemicals, oil and most process industries. Brewing, distilling. Potteries. Boilers. Air-conditioning. Domestic appliances. Jet engine controls. Nuclear reactors. Roadmaking
	Thermocouples		X				
	Resistance thermometers		X				
	Radiation pyrometers		X	X			
Viscosity	Timing falling weight		X	X			Chemicals, oil, rubber and some food processing
	Torque to rotate drum		X				
Surface finish and flaw detection	Stylus	X					Metalworking industries. Paper. Plastics, foils. Glass and optical
	Toggle switch	X	X				
	Electromagnetic transducer		X				
	Piezoelectric crystal		X				
	Eddy currents		X				
	Ultrasonics	X	X				
	X-rays		X	X		radiation	
	Reflectivity		X	X			
	Fluorescent magnetic powders and fluids			X			
	Penetrant dyes			X			

continued

Appendix II—*continued*

Quantity to be measured	Methods	Main techniques employed					Industries in which important, and other uses
		Mechanical	Electrical	Optical	Chemical	Other	
Hardness	Mechanical indentation	X		X			Metalworking industries. Rubber. Plastics
	Mechanical abrasion	X					
	Magnetic permeability		X				
Weight	Lever and weight	X					Process industries. Bakeries. Transport. Cranes. Aircraft trim
	Lever and spring	X					
	Resistance strain-gauge		X				
pH	Calomel and glass electrodes, etc.		X		X		Chemicals, oil process industries in general. Textiles, paper-making. Brewing. Horticulture. Boilers
Humidity	Dewpoint determination		X	X			Process industries. Brewing. Textiles. Agriculture (grain storage). Air conditioning. Electrical manufacture
	Wet and dry bulb thermometer	X	X				
	Electrical conductivity		X				
	Electrical permittivity		X				
	Chemical methods				X		
Chemical composition (gas)	Thermal conductivity		X				Chemicals, oil. Boiler control
	Microwave spectrometry		X				
	Magnetic permeability		X				
	Refractive index			X			
	Infra-red spectrometry		X	X			
	Mass spectrography		X			vacuum techniques	
	Chromatography				X		
Chemical composition (liquid)	Permittivity		X				Chemicals, oil. Plastics. Food and other processing industries
	Polarography		X	X			
	Titration				X		
	Nuclear magnetic resonance		X				
	Refractive index			X			
	Infra-red spectrometer		X	X			
	Chromatography				X		
Chemical composition (solid)	Electron microscope		X				Mining and metallurgical industries. Steel and non-ferrous metals. Metal working industries. Food and other process industries
	X-ray spectrometry		X				
	Raman spectrometry			X			
	Emission spectrometry		X	X			
	Ultra violet spectrometry		X	X			
Nuclear radiation	Geiger counter		X				Nuclear power. Hospitals. Prospecting. Plastics. Sterilisation of food. Thickness gauges and level controls (see above)
	Ionisation chamber		X				
	Scintillation counter		X	X			
	Photographic film			X	X		
Electrical quantities, voltage, current resistance inductance capacitance	Many different electrical methods	X	X	X			Electric drives in all industries. Furnaces. Welding. Electroplating. Electrostatic painting. Transport. Communications. Domestic appliances. Entertainment industry
Other control system components							
Amplifiers	Mechanical torque	X					
	Hydraulic valve	X					
	Jet amplifier	X					
	Thermionic valve		X				
	Magnetic		X				
	Transistor		X				
	Galvanometer		X	X			
	Rotary electric	X	X				
Motors	Hydraulic ram	X					
	Pneumatic ram	X					
	Turbines	X					
	A.c. and d.c. motors		X				
	Torque motors		X				
Pumps	Reciprocating	X					
	Centrifugal	X					
	Electromagnetic (for liquid metals)		X				
Heaters	Resistance heaters		X				
	Induction		X				
	Solid fuel burners	X			X		
	Oil burners	X			X		
	Nuclear reactors					nuclear physics	

Appendix III

Proposed Syllabus for Ordinary National Certificate in Instrument Technology

MATHEMATICS

Year S.1

Elementary rules and operations of arithmetic and algebra. Fractions, factors, powers and roots.

Equations, simple, quadratic and simultaneous. Graphical solution—Analytical solution.

Areas and volumes

Trigonometric ratios and identities—solution of triangles.

Vectors—addition and subtraction of vectors.

Year S.2

Simple curves—parabola, ellipse, hyperbola.

Differentiation and Integration. Application to area, centre of area, moment of inertia, etc. Guldinu's (Pappu Pappus theorem). Maxima and minima.

Sinewaves—superposition of sinewaves.

Logarithms and exponentials

Year S.3

Series—arithmetic and geometric progression. Binomial expansion and other simple series—convergence.

Elementary statistics—mean, mode, scatter, standard deviation. Error of experimental observations—approximations. Plotting experimental data and fitting equations thereto.

PHYSICS

Year S.1. Structure and Properties of Matter

The atomic structure of matter.

Elements and compounds: atoms and molecules. The gaseous, liquid and solid state.

Structure of the atom: nucleus and electrons. Atomic number and atomic weight. Periodic classification of elements and associated electron structure. The bonding of atoms: covalent and ionic. Valency.

Structure of the molecule. Laws of chemical combination. Molecular weight. Chemical nomenclature. Simple chemical calculations, including combustion of gases and solids. Equivalent weight.

Physical properties of gases. Kinetic theory (descriptive). Density and viscosity. Perfect gases: Boyle's and Charles' Laws: absolute temperature. Avogadro's hypothesis. Condensation and evaporation; effects of pressure.

Physical properties of liquids: density, viscosity and surface tension. Ionisation. Electrolysis. Electrochemical equivalent. Acids, bases and salts. Titration, indicators, pH. Crystallisation and solution.

Crystal structure and atomic arrangements. Metallic bonding. Physical properties of solids; yield point and fracture. Outline discussion of conductors, semi-conductors, and insulators. Magnetic effect of an electric current. Corrosion.

Effects of heat transfer on solids, liquids and gases. Expansion. Isothermal and adiabatic changes. Changes of enthalpy associated with changes of state. Heats of reaction and calorific values. Temperature and its measurement.

Structure of the nucleus. Phenomena associated with radioactivity. Isotopes.

Year S.2. Mechanics and Energy

Kinematics. Rectilinear motion. Relative and resultant velocity and acceleration. Parallelogram law. Angular motion: angular velocity and acceleration. Instantaneous centre. Motion in a circle and simple harmonic motion. Measurement of linear and angular velocity.

Kinetics. Forces and mass. Newton's Laws. Resultant force. Equilibrium of co-planar forces. Force diagram for simple framed structures. Moments. Levers. Pressure, direct stress and shear stress. Friction and lubrication. Simple shear force and bending moment diagrams. Stresses in thin cylinders and spheres. Magnitude and position of force due to hydrostatic pressure on a plane surface. Bernouilli's equation: flow through orifices and venturis. Force exerted by a jet of fluid. Pressure differences to accelerate a column of liquid in a pipe and to maintain motion.

Mechanics of deformable solids. Elasticity and plasticity. Measurement of elastic properties and strengths of materials. Measurement of force and pressure by their effects on elastic materials. Theory of bending. Theory of twisting. Simple thermal effects.

Energy. Work and heat. Power. Kinetic energy, potential energy (gravitational and elastic), internal energy (thermal), electrical energy. Units. Determination of conversion factors: 'the mechanical equivalent of heat': the electrical equivalent of heat. Specific heat.

Transfer of energy by conduction. Thermal conductivity and heat transfer coefficients. First order time lags treated descriptively and experimentally.

Transfer of energy by (electromagnetic) radiation. Frequency, velocity of propagation, and wavelength. Sources of the spectrum (from radio waves to X-rays). Colour. Rectilinear propagation, reflection, shadows, dispersion interference and diffraction. Detection of radiation.

Transfer of energy by elastic waves. Transverse and longitudinal waves. Frequency, velocity of propagation and wavelength. Sources of the spectrum (from 'subsonic' to ultrasonic). Rectilinear propagation, reflection, interference and diffraction.

Waves. Detection of radiation.

Year S.3. Geometric Optics

Reflection and refraction at plane surfaces—laws of reflection, nature and position of image, rotation of mirrors—laws of refraction, refractive index—critical angle—total reflection—prisms. (Examples—real and apparent depth—periscope.)

Reflection at spherical surfaces—nature, size and position of image, graphical constructions—mirror formulae—magnification. Definitions—centre of curvature, pole, principal axis, focal length, etc. Determination of focal length of concave mirror for real image.

Parabolic reflectors

Refraction at a spherical surface—convex and concave lenses. Lens formulae—definitions—optical centre, principal focus, focal length. Determination of focal length of convex lens. Two thin lenses in contact and separated.

The eye and simple optical instruments—simple and compound microscope—telescope.

Photometers

Electricity and Magnetism

Electric fields

Electric charge—electric field—inverse square law—potential difference in terms of work—equipotential surfaces. Faraday cage.

Electric circuits

Electric current—resistance—electromotive force—Ohm's law—units of current, potential difference and resistance.

Simple networks

Resistances in series and parallel. Sources and sinks—Wheatstone bridge—potentiometer—resistivity—temperature coefficient of resistance—resistance thermometer.

Simple magnetism

Magnetic effect of an electric current—elementary magnets—modern theory of magnetism—magnetic materials, permanent magnets, line of force—earth's magnetic field.

Magnetic circuits

Magnetic field due to straight wire and solenoid—electromagnets. Magnetic circuits, flux-density, magnetomotive force, hysteresis. Transformers, relays.

Electromagnetic induction

Force on a current carrying conductor. Faraday's and Lenz's laws—galvanometer, simple motor. A.c. generator.

Construction of a.c. and d.c. instruments—soft iron, moving coil, and hot wire.

Primary and secondary batteries

Electric field in an insulator—potential difference and capacitance displacement current—permittivity—capacitors in series and parallel.

Chemistry originally included in O.N.C. syllabus but not covered by structure and properties of matter syllabus.

Chemical and physical properties of oxygen, hydrogen and nitrogen.

Chemistry of air and water.

Brief account of the properties of some industrially made substances.

Catalysts.

Year S.1. Engineering Drawing

The principles of Engineering Drawing. First angle and third angle projection. The British Standard for Engineering Drawing Practice (B.S.308:1953), excluding clauses 18, 19, 20 and 21.

The preparation of working drawings of engineering components and simple assemblies incorporating standard fastenings.

The construction of loci, conic sections, and other important engineering curves. The projection of lines on inclined and oblique planes. Auxiliary views and sections. Intersections of planes and interpenetrations of solids. The development of surfaces.

APPLIED PHYSICS, MEASUREMENT AND CONTROL

This course is intended to be integrated with the courses entitled "Mechanics and Energy" and "Geometric Optics, Electricity and Magnetism".

The emphasis should be on practical applications and measurement. For each physical quantity to be measured, the principles of the methods used should be taught together with the range for which useful, methods of calibration, causes of errors, the reasons for choice and the relative advantages and disadvantages in industrial and scientific applications.

Principles of measurement

Scales, datum, absolute units. Standards.

Simple metrology

Measurement of length, angle, etc. Use of micrometer, height gauge, slip gauges, travelling microscope.

Measurement of weight, mass, volume and density, leading up to measurement of level.

Measurement of time and speed

Clocks, revolution counters, tachometers. Recorders, including chopper bar mechanisms.

Measurement of pressure

Simple U-tube and other manometers. Ring balance, inverted bell, diaphragm, Bourdon tube and McLeod gauges. Pressure-operated methods of measuring level.

Measurement of quantity and flow

Volumetric meters. Positive and inferential methods of measuring flow. Applications of Bernoulli's theorem. Venturi and orifice plates. Pitot tubes. Rotameters. Weirs and flumes.

Measurement of temperature

Expansion methods. Gas and vapour pressure thermometers. Ambient temperature compensation. Effect of sheath. Optical and radiation pyrometers.

Electronics

Thermionic emission. The diode: construction, space charge, saturation, characteristic curves. Simple half-wave and fullwave rectifier circuits. The metal rectifier. The triode, characteristic curves and valve constants.

Electric indicating, measuring and recording instruments

General principles, design and calibration of moving iron, dynamometer, induction, electrostatic and moving coil instruments. Measurement of direct and alternating currents, potential difference and power. Rectifier and thermocouple meters. Use of potentiometer and Wheatstone bridge. Moving coil and self-balancing potentiometer recorders.

Electrical methods of measuring temperature

Thermo-electric and resistance thermometers. Cold junction and load resistance compensation.

Remote transmission

Mechanical. Fluid pressure systems. Electrical systems. Use of G.P.O. lines.

Automatic control

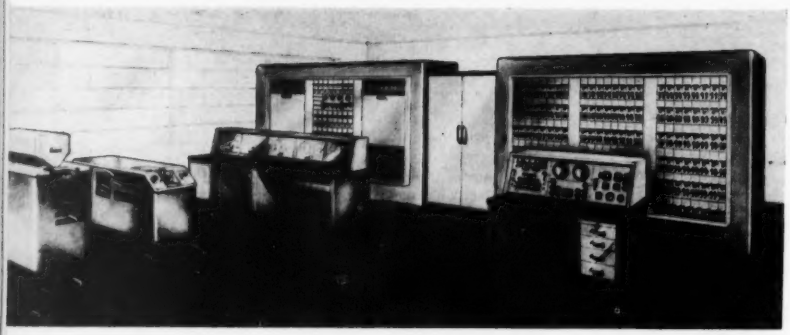
Basic elements of a control system. Closed loop and open chain. Programme controllers. Discontinuous and continuous control. Three-term controllers.

Note—To fit in with the "Mechanics and Energy" syllabus, it is probable that the items up to and possibly including "Measurement of Temperature" should be covered in the S.2 year.

Appendix IV

Proposed Time Table for National Certificate Courses in Instrument Technology

YEAR	PERIOD I	PERIOD II	PERIOD III	PERIOD IV For students working for an additional qualification		
				Grad. I.E.E.	Grad. I. Mech. E.	Grad. Inst. Physics
S.1	Mathematics	Structure and Properties of Matter	Engineering Drawing	English	English	
S.2	Mathematics	Mechanics and Energy	Applied Physics Measurement and Control	Principles of Electricity	Engineering Drawing	Workshop Practice
S.3	Mathematics	Geometric Optics, Electricity and Magnetism	Elementary Measurement and Control		Workshop Technology	
A.4	Mathematics	Applied Physics	Measurement and Control	Electrical Technology	Properties and Strength of Materials	
A.5	Mathematics	Applied Physics	Measurement and Control	Electrical Technology	Properties and Strength of Materials	
A.6	Mathematics	Measurement and Control, Special Topics	Advanced Control Theory	[Industrial Management] [Industrial Electronics]		



An artist's impression of the finished E.M.I. computer EMIDEC

By R. H. WILLIAMS, A.I.B., F.Inst.D.
Managing Director, Computer Consultants Limited

Computers and the Electronic Office

Part 2. Production Control

The first part of this article discussed the use of electronic computing systems for commercial work and certain conclusions were drawn. In this second part, the use of an electronic computing system for production control in an organisation manufacturing motor cars will be considered.

AN organisation which makes motor cars would be of a reasonable size and would, therefore, require a computing system capable of dealing rapidly with a large volume of work. This would mean installing one of the medium size computers.

The work should be complete in itself, but if one is to aim for the greatest economy, one must consider continually how a particular task will dovetail into the remainder of the clerical work of the organisation. To do this arrangements must be made for data to be produced in its various stages in such a way as to leave "ends". These "ends" could later be tied into other procedures, such as invoicing, ledger work, costing and so on, when it was decided to transfer these aspects of the general work to computer procedures also.

As the factory under consideration is not a new one and is at present producing motor cars, there must obviously be production control procedures in existence. These procedures may be on punched cards or on some form of visible graphic chart or merely manual. But however good or bad they may be, they exist, and this is the important point that must be kept in mind during the whole of the planning.

Another factor that must be remembered is that the production of motor cars has to continue during the change-over from existing procedures to the computer procedure. The most that can be hoped for is to effect a portion of the change-over during some part of the annual holiday, when the factory may be closed down for ten to fourteen days.

Examination of Production Control Procedures

Having accepted the principle that production control procedures exist and that the plans for these procedures stretch possibly for months ahead, some time scale for examining and adjusting these plans periodically must be decided on.

One might wish to examine and make the necessary adjustments to the production control procedures each day, every other day, once a week, once a month or once every three months. Let us assume that we decide that our time scale is on a weekly basis.

We are also going to assume that the reader knows relatively little about computers, and therefore, to start with, we will not pay too much attention to how we would do it computer-wise, but merely consider a system which we could later implement by means of computer "hardware". In designing this system, we will in fact try and simplify it to an extent where it becomes apparent to the reader how computer "hardware" will fit in.

When the time arrives to examine the existing production control plans and make adjustments, the basic new information available is:—

(a) The number of actual motor cars which were manufactured and placed in stock during the last week;

(b) The type and quantity of parts which were placed in stock last week;

(c) The type and quantity of raw materials which were delivered to the factory during the last week;
(d) The type and quantity of sub-contracted parts which were received during the last week;
(e) Estimates of anticipated future sales for specified periods;
(f) Decisions by management concerning sales and manufacturing policies, where they differ from existing notified decisions, and
(g) Details of sales of motor cars and spare parts during the last week.

Stock Control

Each of the motor cars manufactured will be made up of many individual parts, and some of these parts will be common to more than one model of motor car. In turn these parts and sub-assemblies will also be made up of individual parts, and again some of these individual parts will be common to more than one sub-assembly.

The basic parts will either be manufactured by the factory, from raw material, or will be purchased from sub-contractors in certain stages of manufacture.

Where the parts are manufactured by the factory, this will involve basic raw material, machine time, labour for machining and possibly labour for assembly.

The factory will already have "explosion lists" of the particular models of motor cars which they make, which break down the main items to their individual component pieces. Although these lists are in existence, it is as well at this stage to ensure that they are absolutely correct and fully amended to date. It is possible, therefore, to explode a motor car down to its very basic ingredients, and this is one of the present requirements of production control, by whichever method it is carried out.

In addition to arranging to manufacture parts, or to order parts from sub-contractors, it is necessary that these basic items should be in stock, and available as and when required, so that the main work of the final assembly of motor cars shall not be delayed. At the same time, it must be appreciated that whether the parts have been manufactured in the factory or purchased from outside manufacturers, they represent considerable tied-up capital, and the stock on hand must be carefully controlled in such a way as to ensure that the minimum amount of capital is tied up, compatible with the right part being available at the right time.

To do this the stock position will have a maximum and minimum level, which will be largely fixed by past experience and changed from time to time, if production warrants acceleration or retarding.

The most critical level is obviously the minimum level. If, for example, 100 motor cars each having five wheels are being made, and there are only 499 wheels in stock, then the minimum level can be as critical as one, or one car will have to leave the factory with no spare wheel.

The maximum level is also critical, where a particular part or sub-assembly is expensive, for example, the stock holding of complete engines, which represent a considerable percentage of the value of the car, must not be allowed to increase drastically above the actual requirement, otherwise the expense of tying up too much capital in engines held in stock is incurred. Obviously the maximum stock holding of something cheap, like a washer, would not in any way be as critical although even items as small as washers should not be allowed to get entirely out of hand.

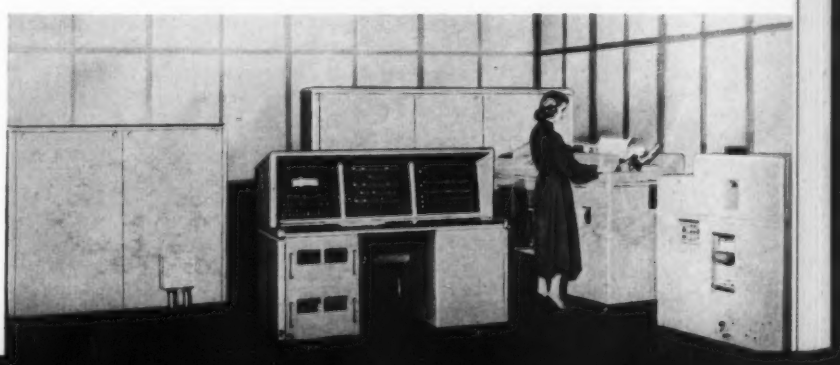
The situation is, however, not as simple as merely ordering or manufacturing the exact number required to bring the stock holding up to the minimum level, because the difference in the cost of manufacturing one particular type of bolt, for example, as opposed to the cost of manufacturing 500 such bolts (once the machine was set up for this), would be very disproportionate. Also, when parts are bought from sub-contractors, they experience the same phenomenon, and if competitive, are able to pass the benefit of this on to the purchaser by way of giving discount for certain sizeable types of purchases. This is usually described as an "economical manufacturing batch size", or the "economical purchasing number".

When maintaining the stock position, therefore, it becomes necessary not only to ensure that the minimum holding is held, and that the maximum holding is not exceeded unduly, but also to ensure that replenishment takes into account the economical manufacturing batch size or purchasing number.

Stock-holding Tolerances

Thus certain tolerances should be placed on the minimum stock holding, and on the maximum stock holding, and this will depend on other facts entering into the matter. An example showed how critical a deficiency of one wheel might be in the manufacture of 100 cars. This might not, in fact, be as critical as described, because circumstances might be such that all the cars would not be required during the first few days of the particular production control period, and by the last few days of this period one would have received a fresh batch of wheels, although strictly speaking these were not taken fully into account until the next control period. But knowing this, the person responsible for allotting the tolerance might allow a tolerance of say 2% in the minimum holding of wheels.

In the same way, the manufacturing requirement for wheels on paper might be 42. In point of fact the economical manufacturing batch size might be 100.



The I.C.T. Hollerith 1202 *computer, similar to one used for production control procedures on printed cards at Letchworth*

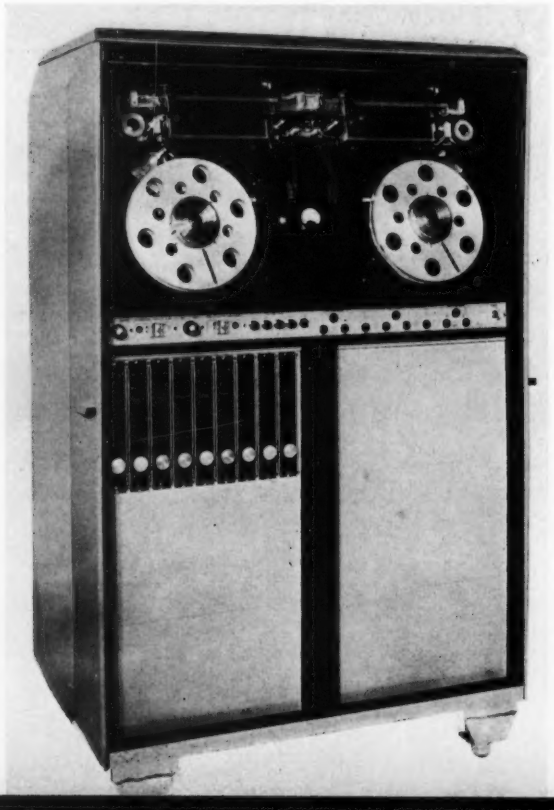
In this case the actual final holding of wheels would be in excess of the maximum holding. Nevertheless, although wheels are a fairly expensive item, the difference in the saving of manufacturing the economical manufacturing batch size might be such as to justify an allowance of a tolerance of say up to 30% above the maximum holding.

In production control, the tolerance is usually much more critical on minimum rather than on maximum holdings, although there are exceptions to this. For example, with certain sub-assemblies, which are extremely expensive, and where the production control cycle is for a lengthy period of say two months or even more. This sometimes applies to the manufacturing of large items such as diesel engines.

Basically within the time cycle, and with production control in full swing, what is required therefore is to feed in all the new information available as described earlier. This will in turn affect certain stock positions and then explode the new requirements, which in turn will again affect stock and manufacturing procedures. If the resultant answer says that within the tolerances allowed there is no necessity to make any change then existing plans could remain until the next cycle comes round again.

It is more than probable, however, that the explosion will reveal that certain parts or materials have been overstocked. If this is the case very little can be done about it except that it might affect management policy decisions for the next cycle. If the explosion reveals that there are insufficient parts or sub-assemblies or raw material in stock to complete the present cycle then steps can be taken to remedy the matter. If the parts or sub-assemblies are manufactured in the factory then the machine loading will have to be exploded and the machine time re-allocated. If there is not enough machine time on existing shifts then overtime must be planned or arrangements made to sub-contract for parts which had previously been made by the factory.

The stock position of each item of raw material will similarly have to be examined and additional orders placed or existing orders hastened as may be necessary.



Magnetic tape unit manufactured by Epsylon Industries Ltd.

Use of the Computer

This is basically, and in a simplified form, what we want to achieve by using a computer. It will be noticed that there is comparatively little new information to be fed into the system, and comparatively little information will be required from the system, because the principle of management by exception can be evoked and the computer told to advise us only of matters requiring our attention.

To do this, however, a tremendous amount of analysis, sorting, comparison and cross reference is required, and production control arranged in this way is one of the few instances where a computer installation has little new input and printed output, and quite a large amount of logical work to carry out. Usually with commercial work, the reverse is the case. Because basic input and output to and from the computer are the most troublesome factors, there is a good case to be made for making production control one of the early computer applications.

It has the additional benefit that it is comparatively easy to arrange for the "loose ends" to tie up in such a way that on the days when the system is not being used for production control work, the computer can be used to cost out the various procedures, provide figures as a by-product for pay-roll work, and generally afford the organisation using the computer an excellent way of achieving some real economical saving in the form of tight control of production. There can be much less wastage, particularly in industries bedevilled by very frequent modifications.

In applying this procedure to a computer, the various records would be kept on magnetic tape and the whole of the work outlined, broken down into some six or eight computer "runs", depending upon the maximum number of magnetic tape units which the computer could handle at any one time.

The stock record files would be written on tape giving:—

(a) the stock reference number;
(b) the maximum holding and tolerance;
(c) the minimum holding and tolerance;
(d) the economical batch manufacturing or re-ordering size;
(e) alphabetical description;
(f) quantity on hand for each item;
(g) the supplier, if sub-contracted, and
(h) the number on order or under manufacture.

When making the adjustment to this stock record, the changes required would be fed into the computer, together, with the issues and receipts and records of any orders made or under manufacture.

Similarly the "explosion" of each motor car would be recorded on tape and this explosion list would

merely be extended by the computer to the various new requirements by simply multiplying by the number of cars of that model which were to be manufactured.

After carrying out a similar procedure with the other models of cars under manufacture, the details would be aggregated for each individual part and applied to the stock tape to adjust it accordingly. These stock tapes and magnetic tapes containing similar types of information which have been edited or amended from time to time would, in fact, not be written on by the computer. Instead the original tape and the tapes containing the modified information would be combined to produce a fresh magnetic record tape, which, in turn, would become the original tape for use the following time. The original tape, unchanged, could be filed if required, or used again if not required to be kept.

While the computer was performing the various modifications to the stock records, it would at the same time be producing further tapes indicating what parts were required to be manufactured, tapes showing what parts were to be re-ordered, and tapes indicating matters requiring attention, which would then be printed out for examination. In later computer runs the tape of required parts to be manufactured would again, in turn, be exploded by applying to it a magnetic tape, giving the necessary details of machine loadings and the requirements for the manufacture of the parts, specifying the labour, machines and raw materials required. This would again produce individual tapes for subsequent printing as part of the computer run, showing the requirement for labour, machining and raw material.

Where more than one possible alternative presents itself and experiences or changes have occurred which cancel previous experience and so make it difficult to decide on the best procedure, the operation may be simulated on the computer and the optimum method decided upon.

Pegasus common language data-processing system

Without generalising dangerously, it is difficult to expand further on the actual computer side of this procedure without relating it to a specific computer.

In this particular article we have mentioned a medium-sized installation using magnetic tape. On a smaller scale effective savings could be made with a punched card system, and International Computers and Tabulators Limited at their Letchworth factory are using just such a system and thus benefiting from their own experience.

Next month we propose to deal with the use of computers for the despatch of goods and the clerical procedures following this.

We shall again take the example of our motor car manufacturer, and try and indicate how this other work will tie up with what we have just now been discussing.

NEW PATENTS

The following extracts have been taken from specifications obtained from the Patent Office, and permission to publish has been given by H.M. Stationery Office. The Official Journal *Patents* can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2.

Patent No. 797,722. Transducers.
The Foxboro Company Ltd. (*U.S.A.*). (*Application No.* 15005/56.)

The invention relates to transducers for producing pneumatic pressure signals proportional to electrical input signals—especially in remote control systems such as those where the process is spread over a large area like a petroleum refining plant. The aim of the transducer featured is to produce pneumatic signals proportional in magnitude to electrical input signals, the transducer being furnished with a pivotally mounted force bar carrying a coil to receive the input signals. A magnetic circuit includes an air gap in which the coil can move and at least one permanent magnet produces flux of constant magnitude across the air gap so that the flow of current through the coil causes a proportional torque to be applied to the force bar. Pneumatic means under the control of the force bar, coupled to feed-back means, applies a torque to the force bar that is equal and opposite to the torque caused by the coil when the force bar is in a position such that the output pressure corresponds to the input signal.

Patent No. 798,021. Digital Data Storage Apparatus employing Spin-echo Technique.
International Business Machines Corporation (*U.S.A.*). (*Application No.* 19972/55.)

The spin-echo technique comprises a method of storing information in the form of electrical pulses applied to samples of suitable chemical materials and subsequently recovering the information as "echo" pulses produced by nuclear induction. An aim of the invention is to provide a spin echo memory method including the introduction of discriminator pulses for achieving selective production of either mirror type or simulated echo signals from a single storage medium. A further claim is that the method eliminates spurious or undesirable interpulse echo signals, thus enhancing

the precision, uniformity and strength of the desired echoes. The study of free nuclear induction and spin echo has been dealt with in various publications but the specification features the general principles of spin-echo technique before proceeding to an exposition of the present invention.

A further development of this invention is featured in Patent 798,279 under Application No. 22902/55.

Patent No. 798,017. Combined Data Input Machine and Data Recording Device.
The National Cash Register Company (*U.S.A.*). (*Application No.* 36485/56.)

This invention is concerned with a data recording system in which data recorded on an input machine such as a cash register can be perforated in code on a tape. In such arrangements where one or more punches are to be operated in response to a signal transmitted from a single input line, it is desirable to avoid any electrical feed-back which would cause the operation of undesired punches. It is the object of this invention to overcome such feed-back with its attendant disadvantages.

Patent No. 797,941. Storage of Digital Information.
National Research Development Corporation. (*Inventor: F. C. Williams.*) (*Application No.* 31155/53.)

This invention relates to apparatus for the storage of information in binary form. Such information stores use digital storage units in the form of a magnetic core of material with a suitable degree of remanence in which the polarisation of the remanent magnetic induction is used to indicate which of the two kinds of digit element is registered therein. Writing of information into a core may be effected by applying an appropriate magnetising force in the particular polarisation sense chosen to represent the required kind of digit element. Reading of stored information may be effected by applying to the core a magnetising force in a given polarisation sense and detecting whether or not the core undergoes a reversal of its polarity of magnetisation. Another form of storage element obtains equivalent effects with respect to remanent electric induction instead of remanent magnetic induction. A principal object of the invention is to provide means for reading out stored information from such forms of storage device without effecting the destruction of the information record previously held in the store.

Patent No. 797,927. Data Reduction System.
Victor Adding Machine Co. (*U.S.A.*). (*Application No.* 33677/55.)

The invention relates to apparatus comprising electronic and mechanical means adapted for converting a number of simultaneous variable voltages representative of variable quantities such as weight, temperature, velocity, phase, barometric pressure, cosmic ray intensity, etc., into a record, such as punched cards or a printed record, in which digital values are recorded for the variables at discrete intervals. Typical of information of this kind is that telemetered from rockets in flight. The apparatus provided is primarily concerned with accepting analogue data in the form of variable voltages over a number of transducer channels simultaneously, and directly controlling therefrom a standard read-out device such as a card punching machine. The apparatus claims to function with very little operator intervention and with greater accuracy than has hitherto been possible.

Patent No. 798,263. Mechanical Resolving Mechanism.
Elliott Brothers (*London*) *Ltd.* (*Inventor: John Tindale.*) (*Application No.* 25446/54.)

This invention relates to mechanical resolving mechanisms comprising a spherical ball caused to rotate about its centre by an input roller bearing upon the surface of the ball. This roller rotates about an axis parallel to a tangent at the point of contact with the surface of the ball and is angularly adjustable in accordance with the value of the function to be resolved. Two output rollers, each bearing upon the surface of the ball and each capable of being rotated by rotation of the ball, have their axes parallel to a tangent to the surface of the ball at the points of contact. The points of contact of the three rollers with the surface of the ball are so disposed that lines drawn from the centre of the ball to them are mutually perpendicular. The axes of rotation of the two output rollers are contained in a common plane which passes through the centre of the ball and is normal to the plane containing the point of contact of the input roller. Each of the output rollers is rotated at a speed which is a function of the speed of rotation of the input roller, the diameter of the output roller concerned and the orientation of the plane of rotation of the ball, this latter being determined by the orientation of the axis of rotation of the input roller. Thus if the speed of rotation of the input roller is constant, the speed of rotation of the two output rollers will be respectively a sine and cosine function of the angular displacement of the axis of rotation of the input roller from a zero position. The method adopted in this invention is claimed to be preferable to the use of gears which require to be very accurately made and increase the expense of the mechanism.

Patent No. 798,312. Electronic Digital Computer.
Deutsche Telephonwerke und Kabelindustrie Aktiengesellschaft. (*Germany*). (*Application No.* 31297/55.)

The complicated design and high cost of existing electronic computers has been a considerable bar to their general use. The development of decimally working electronic elements has opened new possibilities of relatively simple computers. The present invention features a system which provides an impulse controlled computer for adding, subtracting and multiplying and comprises counting elements characterised by one entry register and one totals register. Each such register comprises one such counting element per digit order. The entry and totals registers are connected in such a way that any value in the entry register is transferred to the totals register by a train of counting pulses equal in number to the radix of the counting elements passed in parallel to all the orders of the entry register. Other features of the mechanism are described and illustrated diagrammatically in the specification.

(*Continued on page* 637)

B.C.U.R.A. 21st Anniversary Open Days

IN April, 1938, the British Coal Utilisation Research Association was formed to "promote research and other scientific work in connection with the utilisation of coal and its derivatives". To mark its 21st Anniversary B.C.U.R.A. held open days at its Leatherhead laboratories from 22nd to 24th April.

Current researches in the industrial, domestic and basic fields were illustrated by exhibits and displays. Among the problems concerning coal utilisation in industry and the home are: improved methods of using small coal; meeting the needs of competition from oil; and assisting the implementation of the Clean Air Act.

Research at Leatherhead is being directed especially towards improving and devising appliances suitable for burning small coal, developing methods for the automatic control of combustion and towards means for reducing atmospheric pollution from coal-burning appliances and also towards the development of new products from coal.

Air/Fuel Ratio Controller

The air/fuel ratio controller developed within the Association has enabled the carbon dioxide content of the flue gases from an Economic boiler to be maintained within narrow limits over a wide variation of boiler rating. For example, with a given coal, from 30 to 110% of the maker's rating, a CO_2 content within $\pm 1\%$ can be maintained.

The controller has also been tested on a Lancashire boiler in an industrial boiler-house. It was found that whereas the CO_2 content in an adjacent manually-operated boiler dropped by up to 4% during changes in load, the boiler with controller held a CO_2 content between 11 and 13% throughout the test period except during ashpit clean-outs. Arrangements for installing more controllers in industrial boiler-houses to obtain further experience are well advanced.

Automatic Control for a Miniature Chain-grate Stoker

A method of automatic control for a miniature chain-grate stoker used to fire central heating boilers ($\frac{1}{2}$ to 2 million B.t.u./h) in offices or blocks of flats has been devised and this permits $\frac{1}{2}$ inch small coal to be burnt smokelessly at high efficiency over a wide range of heating loads. The load on the boiler, which may vary by a factor of 10 to 1, controls the rate of coal feed to the grate so as to maintain the required boiler outlet temperature.

A Sunvic proportional controller controls the rating of the boiler, the position of the primary air damper and the setting of the four undergrate dampers which distribute the primary air along the grate to ensure complete combustion without unwarranted excess air. Tests using $\frac{1}{2}$ inch to 0 coal smalls have shown virtually smokeless combustion and high efficiency over the whole range of heating loads, and further developments are in progress.

Basic Research

The Basic Research Laboratories include an Analytical Department, a Chemistry Department and a Physics Department.

The main researches of the Physics Department concern coal grinding and dust assessment. The methods of sampling dusts from stacks, developed by the Association, have aroused much interest from those concerned with enforcing or complying with the Clean Air Act. The automatic particle sizing apparatus that has been developed can with special care be employed down to 2 microns and can be used to carry out eight analyses a day. An advantage of the instrument is its flexibility in regard to the choice of size ranges, but a disadvantage at present is its lack of flexibility in varying the area sampled from range to range.

Another major problem in many coal utilisation studies is the measurement, particularly under plant conditions, of small pressures (in the range 0-10 in. w.g.). For example, the maximum reading of a pitot tube at flue gas velocities is often 0·1 in. w.g. Variable core transformer pressure transducer units permitting the recording of these pressures have been constructed for use with pitot tubes measuring gas velocity during field tests. With this type of instrument a bellows movement of 0·00025 in. gives full-scale deflection.

(*Continued from page* 636.)

Patent No. 798,557. Electrical Testing Apparatus. *British Central Electrical Company Ltd. and John Krimholtz.* (*Application No.* 21512/55.)

This invention relates to a system for testing earth connections attached to electrical apparatus. The apparatus is of the kind comprising a transformer, the primary of which is connected to the supply mains and the secondary on one side with a connection to earth and on the other in series with an ammeter and a terminal for connection with the apparatus to be tested. The invention is of a type similar to that described in Patent No. 543,660 but is designed to overcome the disadvantage resulting from the lengthy procedure necessary in its use. With this arrangement the primary of the transformer is adjusted in accordance with the voltage of the supply mains and thus, with the terminals of the secondary connected respectively with the apparatus being tested and with earth, a direct reading can be obtained of the resistance of the earth connection of the apparatus being tested.

The R.E.C.M.F. Exhibition, 1959

Introduction

THE annual exhibition of the Radio and Electronic Component Manufacturers' Federation increases in strength from year to year. The 1959 show reached the record number of 180 exhibitors.

The following account is designed to bring out those products of interest to the instrument industry.

Components for Extreme Ambient Temperatures

In the transformer and choke field, the Gresham "Sepoy" components have the core left exposed. This makes contact with the chassis which acts, in effect, as a large radiating area or heat sink. Transformers utilising this principle may operate in ambient temperatures up to 150°C.

The Ferranti "Hitemp" transformers can function with a winding temperature of 250°C.

Amongst capacitors, the metallised film and metallised paper capacitors of A. H. Hunt (Capacitors) have a wide temperature working range, e.g., from −100°C to +100°C. The Telegraph Condenser Co. Ltd. have introduced a new tantalum electrolytic capacitor with an operating temperature up to 125°C.

The p.t.f.e. insulated wiring of British Insulated Callenders Ltd. allows a temperature of 250°C to be reached with safety.

Amongst heat dissipating devices are the valve shields of the Garrard Engineering and Manufacturing Co. Ltd. These may be built in with new designs or fitted to existing components.

A range of fifty-seven lever type key switches, manufactured by The Telephone Manufacturing Co. Ltd., has now received type approval to RCL153 for class H2. This covers the range −40°C to +70°C.

The C type transformer cores of the English Electric Co. Ltd. are designed in a wide range of sizes and are produced from cold rolled grain oriented steel strip. They are stable up to 250°C.

General Equipment

The new coil winding machine of Avo Ltd. is capable of winding layer wound coils without the use of any medium of interleaving. The normal mechanical coupling between the headstock and the traverse has been dispensed with and both are driven by independent motors, whose relative speeds are electronically controlled by a sensing head. This monitors the wire-feed angle so as to ensure that as far as practicable each turn is laid precisely beside the preceding turn. A greatly improved space factor results—of importance for such components as relays and solenoids, especially the miniature types. The more precise rectilinear configuration of coils thus wound opens up many possibilities of the use of self-supporting coils where formers were previously necessary.

Not the least important part of the electronic components industry is that devoted to the design and production of cases, cabinets, racks, panels, consoles, etc. One typical firm is Hallam, Sleigh & Cheston Ltd. Amongst their latest developments is the single bolt fixing of components. All "Widney Dorlec" main frame members are now provided with an internal slot. This holds bolt heads which are used for the quick assembly both of corner pieces and internal equipment. All that is necessary is to cut, with a straight saw cut, the necessary length of main frame member and bolt it to the appropriate corner castings.

Mounting standard instruments has hitherto required a series of carefully tapped holes. The "Widney Dorlec" scheme introduces a system which holds a loose block in position where required for each instrument. This arrangement releases manufacturing limits, is economical by saving unwanted holes and avoids difficulties of stripped threads and paint in the threads long associated with orthodox methods.

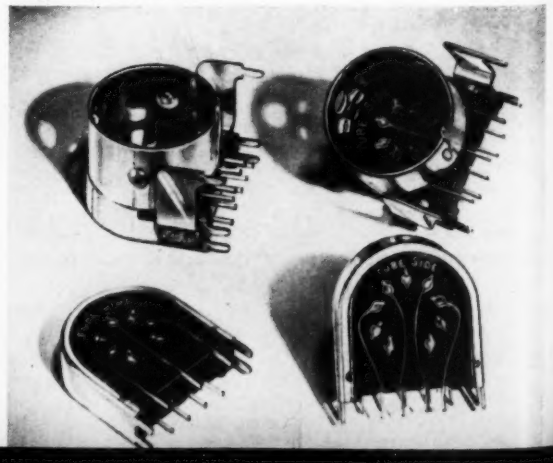
Quick and accurate assembly of framework is a feature of the products of Alfred Imhof Ltd. Fifty-six new components have been introduced, and by means of new connectors and extrusions framework may be arranged for internal or external angles between 22½° and 90°.

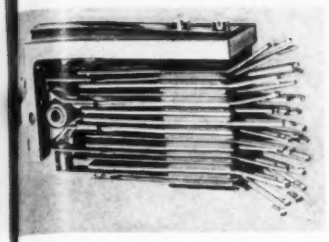
Instruments

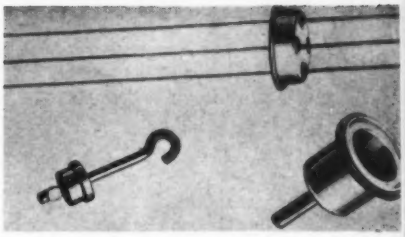
Instruments displayed at the R.E.C.M.F. exhibition are in the nature of test equipment.

Taylor Electrical Instruments Ltd. have produced two new multi-range test instruments. Model 100A

Right angle valve holders







Left: Typical TMC lever relay to RCS 153. *Right: Three glass seals shown by Belling-Lee. (Top)* L.1442 *transistor seal for use with low power transistors. (Bottom left)* L.1440 *single terminal glass seal primarily designed for individual leads to a power transistor. (Bottom right)* L.1441 *rectifier glass seal*

has a sensitivity of 100,000 ohms per volt. In addition to the normal ranges, there is one for 10 μA, and resistances up to 200 megohms may be measured without external aids. A useful pocket model is No. 127A which has all the normal ranges and possesses a sensitivity of 20,000 ohms per volt.

A new megohmmeter of British Physical Laboratories, Type RM185, measures resistance up to 400 million megohms (4×10^{14} ohms).

Miniaturisation

The efforts to produce components which take up less and less space without impairing technical efficiency have resulted in novel designs. For example, Electronic Components have produced a rotary stud switch in which the switching section is smaller than the knob and, in fact, is incorporated in the knob itself. The space occupied inside a panel or chassis is virtually nothing; and removal of the knob reveals the studs and brush member. This makes for easy cleaning or lubrication.

The same firm has also developed a fader in which two networks are mounted in the same space as one fader previously required. The complete networks, including studs and wiper assembly, may be easily removed. Internal illumination is provided to indicate the operating zones.

Resistors are another component in which miniaturisation is being carried to the limit. For example, amongst the range of Painton and Co. Ltd. is a high stability carbon resistor (Type 70) only $\frac{3}{8}$ in. by $\frac{1}{16}$ in. The standard tolerance is 5%, but 1% or 2% tolerances can be obtained over most of the range which extends from 5 to 250,000 ohms.

Within the field of miniaturisation, the various insulators of Harwin Engineers may be included. One example is the sub-miniature stand-off insulator. The 8 B.A. size in Alkyd is only some $\frac{3}{8}$ in. high, but may be used at working voltages up to 2 kV over a wide range of humidity and temperature.

Transistors

Mullard Ltd. are now making available packages of specially selected and tested transistors for use in r.f. and a.f. circuits. Each one is guaranteed to provide a minimum overall gain and spreads in overall gain are much smaller than with transistors selected at random. The audio frequency package includes a matched pair of 0678 transistors suitable for push-pull class B outputs together with the driver transistor 0C78D. An output of 500-600 mW can be obtained.

Texas Instruments Ltd. have developed many new silicon tetrode transistors. These are designed to have a high gain at high frequencies. For example, the 3S004 has a gain of 18 dB at 70 Mc/s. In another direction, there are a wide range of Zener diodes covering Zener voltages between 3 and 90 and Zener currents from 150 mA to 20 mA.

Magnetic Materials

Amongst the newer magnetic materials are Comalloy of Murex Ltd., and Supermumetal of The Telegraph Construction and Maintenance Co. Ltd. Comalloy has a BH_{max} of about 1×10^6 gauss-oersteds and can be machined prior to final ageing. Supermumetal has an initial permeability of 50,000 and a maximum value of about 200,000. It can be made in standard size cores enclosed in plastic cases. Operating temperatures are up to 135°C.

Automatic Control of Beet Processing Plant

THE IRISH SUGAR COMPANY are this year expecting bigger yields at less cost from their beet processing plant at Carlow, Southern Ireland: for the first time in the history of the plant, the three-month long round-the-clock production campaign that follows the annual beet harvest is running continuously under fully automatic control. Recording and controlling instruments, supplied by Honeywell Controls Ltd., are maintaining process conditions at a stable optimum, and ensuring such effective use of available heat energy that the plant's fuel bill has already been cut.

Continuous High-Speed Processing

Instrumented continuous processing through a new two hundred feet long diffusion drum replaces the batch processing of previous years, stepping up feed rates to an evenly maintained average of one hundred and twenty five tons of beet per hour. Unprocessed beet loses its sugar content so rapidly that the production campaign is always to some extent a race against the enzyme reaction which sets in as soon as the beet is lifted. Although higher yields per ton of processed beet are not anticipated, the much higher production rate should mean that more beet can be processed while still fairly rich in sugar.

Diffusion Control

In the rotating drum, which is the heart of the diffusion process, pulped beet and water are moved in opposite directions by helical convolutions inside the

(*Continued on page* 644.)

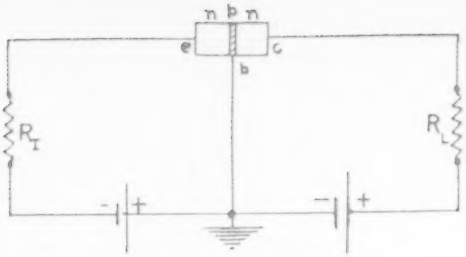


Fig. 1. Basic n-p-n transistor circuit

This part continues the discussion of basic transistor principles with reference to other types than the p-n-p junction pattern.

Transistors in Measurement

n-p-n Transistors

A BRIEF reference to the n-p-n pattern of transistor was made in Part 1. As the item indicates it consists basically of a p-type region sandwiched between two n-type regions. The construction leads to different biasing arrangements compared with the p-n-p version, and these are indicated in Fig. 1 for a common base circuit.

We are not primarily concerned with the methods of manufacture in this series. The procedures, however, give rise to certain classifications appearing on maker's data sheets and it is felt that brief descriptions may be of interest. These are general and may vary in details from firm to firm.

Alloy Junction Transistors

In a typical process, one commences with small elements of p-type germanium. The elements may be of the order of 0·10 in. long, 0·06 in. wide and 0·006 in. thick. Two small indium buttons are placed, one on each side of the element, in a jig, and are held at a temperature of 500°C to 550°C for some minutes. The indium melts and dissolves some of the germanium. After the heating period, the unit is cooled and the germanium re-crystallises out to form p-type material. Thus, a transistor is obtained with an n-type region between two p-types giving the p-n-p formation.

Grown Junction Transistors

For this method of manufacture, the purified basic material, e.g., germanium or silicon is melted in a furnace. A small 'seed' crystal of the same substance is dipped into the molten mass and gradually withdrawn. During the 'pulling' operation, a small quantity of impurity is added to produce an ingot with a useful section of, say, n-p-n formation. This section is removed from the ingot and cut and trimmed into a large number of small transistor elements.

Surface Barrier Transistors

Commencing with small elements of n-type germanium a series of etching and electrodeposition operations produce n-p-n transistors. The emitter and collector electrodes are electrodeposited.

Solid State Diffusion Transistors

In a p-type element, for example, n-type impurities are diffused to a controlled depth into one side by exposure to a high temperature vapour of a specific n-type substance. This is followed by the formation of a small electrode of aluminium by the evaporation process. The aluminium forms a p-n junction with the diffused n-type layer resulting finally in a p-n-p formation.

Equivalent Circuit of Junction Pattern Transistors

The behaviour of a junction transistor, particularly relative to frequency, can be appreciated if the equivalent circuit is drawn. One comprehensive network to satisfy behaviour at all frequencies would be somewhat difficult, and it is preferable to produce circuits at low, intermediate and high frequencies. Fig. 2 is a good approximation at the lower frequencies. r_E represents equivalent emitter resistance, r_C equivalent collector resistance, r_B equivalent base resistance and C_C collector capacitance. The resistances are not simple as several effects such as feedback must be observed. For the present, however, it will be sufficient if they are noted generally as resistances. VG is a voltage generator located in the collector circuit. Instead of the voltage generator, a current generator in parallel with r_C is sometimes used.

The introduction of C_C means the establishment of a time constant network $r_B C_C$. For reasons which will become apparent later in the series it is desirable to minimise the product $r_B C_C$.

By J. T. MILLER, B.Sc., F.Inst.P.

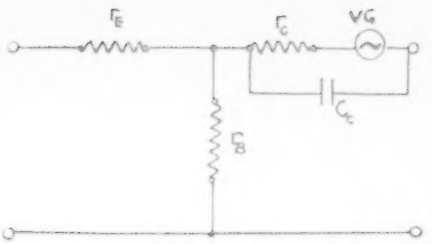


Fig. 2. Equivalent circuit of a junction transistor at lower frequencies

...nd Control — 2

A factor sometimes used in assessing the performance of a transistor is the figure of merit G given by:

$$G = \sqrt{\frac{f_{C\alpha}}{8\pi r_B C_C}} \qquad \ldots\ldots\ldots (1)$$

where $f_{C\alpha}$ = the cut off frequency.

G has the dimensions of frequency. By increasing $f_{C\alpha}$ and decreasing $r_B C_C$ it would appear that the value of G could be improved. It must be remembered, however, that many transistor parameters are interdependent and a compromise is generally necessary.

As the frequency increases, the equivalent circuit is modified. r_B tends to become rather more complex and an emitter capacitance will be introduced. Further modifications are necessary as the frequency is increased to the very high values.

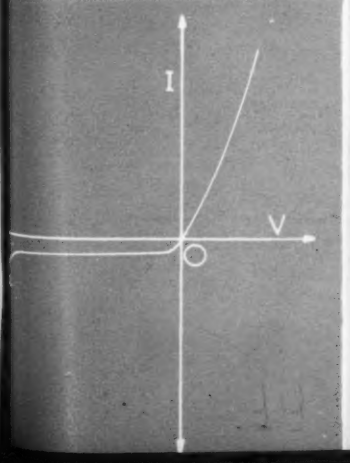
Zener and Avalanche Effects

To explain the Zener and avalanche effects, let us revert to a consideration of a single p-n junction or diode. Suppose we commence at zero and increase the reverse voltage. The characteristic of Fig. 7, Part 1, is obtained at first but with continually increasing voltage an apparent breakdown occurs, and there is a sudden surge of current indicated by ab in Fig. 3. The breakdown path may be traversed indefinitely, and one may operate at any point in the path. The phenomenon has obvious applications in the field of reference voltages.

Originally, a theoretical study by Zener was utilised to explain the action. Briefly, and very broadly, this involves the conception of a 'field emission' to increase the number of charge carriers crossing the barrier region. In the avalanche theory, the continued liberation of valence electrons by collision with charge carriers accelerated by the applied field leads to a self-sustaining action producing a relatively large current.

Point Contact Transistors

So far, junction pattern transistors have been considered. A variation in design is the point contact transistor. Here, two pointed metal wires, of diameter between 0·002 in. and 0·005 in., press against the top surface of n-type germanium. The opposite face carries a relatively large metal electrode forming the base electrode b. If biasing is carried out as in Fig. 4, one wire e assumes the function of the emitter, and the other, the collector c. Observe that the emitter is positively biassed and the collector negatively biassed relative to the base. The voltage current characteristic may be considered in two parts. Imagine that the collector only is in circuit. The voltage-current curve is shown in Fig. 5 in the quadrant. With the emitter connected and properly biassed, the collector current increases as indicated in the lower curve for an emitter current of 1mA. This effect is particularly marked when the emitter and collector electrodes are close together, e.g., 0·001 in. or 0·002 in. separation. The



Curve illustrating the Zener and avalanche effect

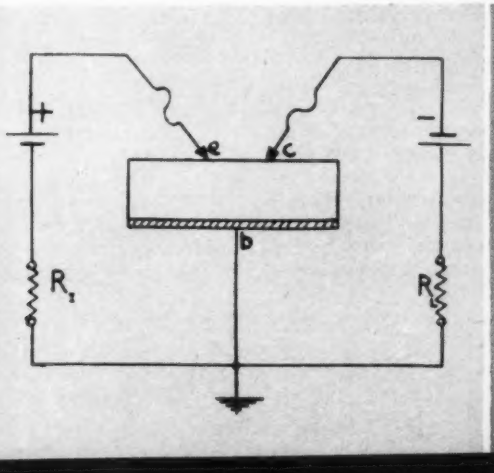


Fig. 4. Basic point contact transistor circuit

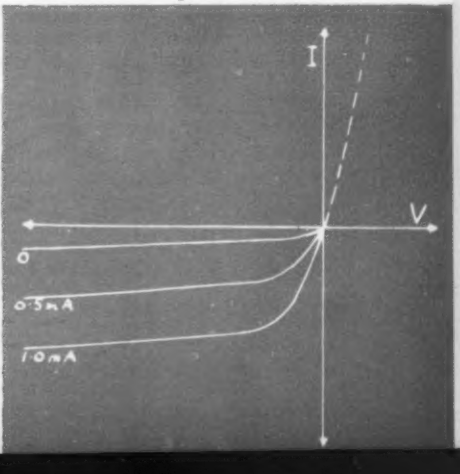


Fig. 5. Typical voltage-current relation collector circuit point contact transistor

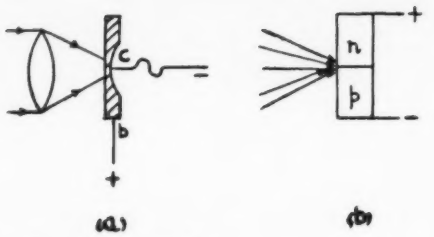


Fig. 6. *Basic phototransistor*

effect is less marked as the distance of separation increases.

The current gain values are interesting. With an electrode spacing of the order given in the preceding paragraph, a gain of more than 1 may be realised. As the spacing increases the gain decreases to values less than unity.

Phototransistors

In conventional designs of transistors, so far discussed, the emitter has been the source of charge carriers which traverse the potential barrier to produce collector current. In the phototransistor, the emitter electrode may be considered to be replaced by a beam of light incident on the unit. Both point contact and junction transistors may be utilised. The light sensitive area, in the case of the point contact type, is immediately opposite the wire contact and an optical system should be employed to focus the light beam on this area. In the case of the p-n junction transistor, the light sensitive area is around the actual junction between the p and n materials. Fig. 6 indicates the principles of the two types with the biasing polarities (Fig. 6a is the point contact phototransistor; and Fig. 6b the junction phototransistor).

Characteristic curves may be drawn up of collector current I_C plotted against collector bias voltage V_C. The curves take the general shape of Fig. 7. Observe that the current at the higher illumination values is sufficient to operate directly a low operating current relay.

Spectral sensitivity is important. The photoexcitation process produces equal numbers of electrons and holes, and the yield of hole-electron pairs per quantum of light absorbed is of especial significance. The quanta energy is inversely proportional to the wavelength and the spectral sensitivity tends to fall off at the longer wavelengths. At the same time, the sensitivity does not increase indefinitely in the shorter wave region as Fig. 8 shows. One explanation given for this is the surface recombination of the excited charge carriers, an effect more pronounced at the shorter wavelengths. The useful sensitivity in the infra-red region should be noted.

Noise in Transistors

The problem of noise in transistors is responsible for a large volume of literature. The subject is complex, thermal, shot and semiconductor noise all being involved. In practice, a noise factor is adopted. This is defined as the ratio of the signal-noise ratio at the input to the signal-noise ratio at the output of a circuit. Alternatively, the definition is taken as the

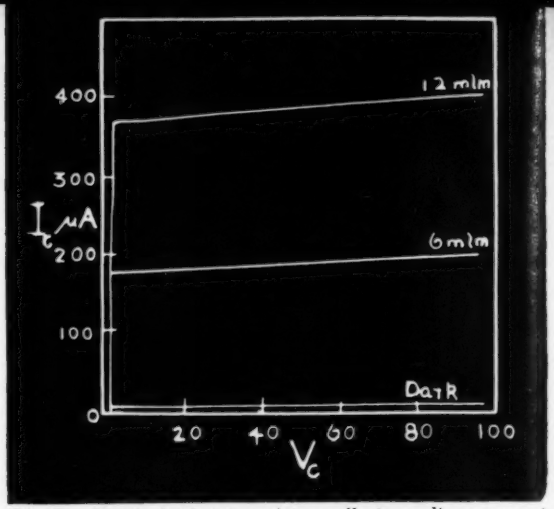


Fig. 7. *Typical phototransistor collector voltage-current curves for various values of millilumens (mlm)*

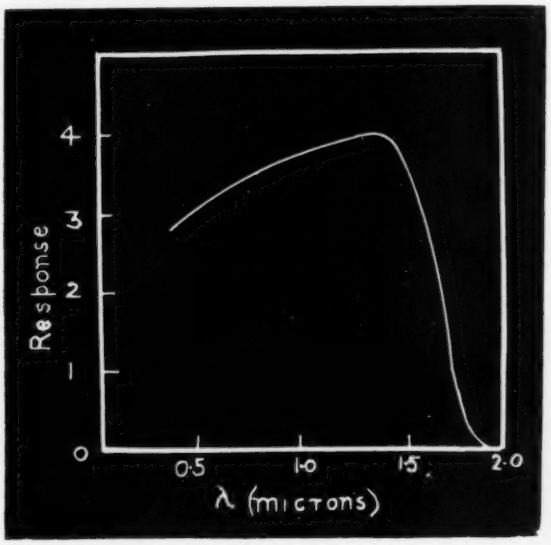


Fig. 8. *Typical phototransistor response-wavelength curve*

ratio of the total noise power at the output of the circuit to the noise-output power due to the *thermal* noise in the input circuit. This figure is normally expressed in dB. It has a special significance in amplifier circuits. For reference purposes, F the noise factor for a conventional single stage common base amplifier circuit is given by:

$$F = \frac{V^2}{4kTR_I(f_2 - f_1)A_I^2}$$

where V = the mean square noise voltage measured across the load R_I
k = Boltzmann's constant
T = the absolute temperature centigrade
R_I = the source impedance
$(f_2 - f_1)$ = the band of frequencies over which measurement is made
A_I = ratio of output to signal voltages.

In any noise factor measurement based on the above formula, the values of the various physical factors will need to be specified.

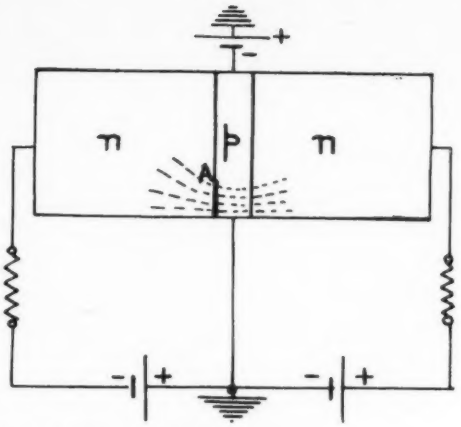


Fig. 9. Basic tetrode transistor circuit

Junction Tetrode Transistors

In an endeavour to improve the high frequency characteristics of transistors, the effect of introducing an additional biassed electrode must be considered. If the base is biassed in the manner shown in Fig. 9, a current will flow in a path perpendicular to the normal current between emitter and collector. The effect of the potential drop across the base influences the biasing conditions of the emitter in such a manner that it only injects electrons across the base to the collector over a relatively small area A in the region of the earthed side. The current from emitter to collector thus takes place over a shorter path with a resultant reduction in base resistance.

The product $r_B C_C$ is reduced and an improved cut-off frequency $f_{C\alpha}$ is obtained. Attendant with this, however, the current gain factor α_{CE} is somewhat reduced.

This may be of the order of 10%-20%.

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FIFTH INTERNATIONAL INSTRUMENT SHOW

THE Fifth International Instrument Show was held at the Tilney Street offices of B. & K. Laboratories Ltd. from 6th-10th April. The firm acts as agent for many of the principal American and Continental firms in the general electronics and radio fields. The major exhibits of interest to readers are briefly reviewed.

Roughness Meter Type 6100 (B. & K.)

This roughness meter has been developed for the measurement and control of surface roughness of machined surfaces. The sensitivity for full scale deflection is 0·3 to 30 μ metres and 10 to 1,000 μ inches c.l.a. The variable roughness width cut-off is 0·75-0·25-0·075 mm (0·03-0·01-0·003 inches). The stylus radius is 12 μ metres (500 μ inches), and the stylus exerts a pressure of approximately 1 g. Reference specimens MA 0014 and precision reference specimens MA 0011 are provided for checking and adjusting the meter and a fine surface pick-up MP 0001 is available on request. Accessories available include a pick-up handle and wire guides.

Humidity Sensing Element (El-tronics Inc.)

The sensing element is a conducting plastic whose electrical resistance changes in proportion to the relative humidity. The sensor operates efficiently even after total water immersion. It is free from calibration drift.

Test Sets (Avo Ltd.)

The Universal Avometer Model 8 has a sensitivity of 20,000 Ω/V on all d.c. ranges from 100 V upwards. The instrument is fitted with an automatic mechanical overload device, a 5 in. (12·7 cm) hand-calibrated scale, and a push-button for reversing the polarity of the movement.

The Multiminor Model 1 is a 19 range a.c./d.c. pocket instrument fitted with rotary switch range selection. The instrument has a sensitivity of 10,000 Ω/V on its d.c. ranges and 1,000 Ω/V on its a.c. voltage ranges.

The Electronic Testmeter, a 56 range balanced bridge valve voltmeter, and a valve characteristic meter Mark III were also exhibited.

Automatic Control of Machine Tools (Micro-Path Inc.)

The Micro-Path system for the automatic control of machine tools utilises magnetic tape to store pre-recorded information for the control of machine tools. Recording is carried out by moving the controlled slide through the motions necessary to produce the finished work, thus eliminating the need for a computer input to record the information on magnetic tape. Thus programming can be performed by a skilled machine operator instead of by a trained programming technician.

(*Continued from page* 639.)
drum. Instruments maintain flows and temperatures at optimum values for efficient extraction.

Drum Input Control

A continuous mechanical weigher measures the weight of beet on a certain section of the conveyor belt at any moment. The vertical movement of the belt under the weight of the beet is used to move the slide-wire on a potentiometer, the voltage of which is generated by a tachometer generator in contact with the moving conveyor belt. By combining the measurement of weight and speed in this way, operators obtain a measure of feed rate in tons per hour which is registered on an ElectroniK potentiometer recorder.

Water input is measured by means of orifice plates and a differential converter transmitter, and controlled by a pneumatic recorder with Air-O-Line pneumatic control.

Temperature Control

A feature of the new system is the continued circulation of the sugar solution obtained at the beet input end of the drum. Known as the circulation juice, the solution is tapped from the drum, heated to a precisely controlled temperature, and used to raise the incoming beet to the required extraction temperature of about 75°C. This use of the circulation juice as a heating medium, combined with the accurate control of the steam valve to the heaters, ensures maximum use of available heat energy and maximum fuel economy. The temperature control system consists of a filled system temperature transmitter Tel-O-Set miniature pneumatic controller and diaphragm control valve. A similar system regulates heat input to the supply water heaters at the other end of the drum.

Flow and Level Control

The feedwater to the drum is acidified in the feed-water tank to the optimum processing pH value of approximately 5·5 by an automatically controlled flow of acid. Although no pH instrumentation as such has yet been installed on the plant, acid is supplied in a set ratio to the flow of water into the tank. The water flow is measured by a differential converter which feeds a pneumatic controller regulating acid supply by means of an acid addition pump.

At the output end of the process, the product is tapped from the circulation juice tank according to the liquid level in the tank. The control system consists of a liquid level differential converter, pneumatic receiver controller and diaphragm control valve. The circulation juice, which speedily increases in sugar content from continued contact with unprocessed beet, is passed from the liquid level control valve to further treatment processes—liming, carbonation and crystallisation.

The instrument panel presents operators with a continuous record of each of these controlled variables, together with temperature indication from certain points in the plant, and flow and temperature records from subsequent stages in treatment.

Mechanical Engineering Research Laboratory

Name Changed and Steering Committee Appointed

The Council for Scientific and Industrial Research announces that in future the Mechanical Engineering Research Laboratory at East Kilbride, near Glasgow, will be known as the National Engineering Laboratory. This is because the Council considers it desirable to emphasise the national character of the Laboratory which is part of the D.S.I.R. organisation and is financed from public funds. It does not imply any change in the field covered by the Laboratory, which will continue to be concerned with problems of mechanical engineering.

The Council has also decided to set up a Steering Committee to look after the programme of the Laboratory. As a result of a recent review of the functions and activities of the Laboratory, the Council is convinced that, between the proper and reasonable activities of the universities and technical colleges on the one hand and research associations and private and nationalised industry on the other, there is an important place for a national establishment for research in mechanical engineering, mainly supported by public funds.

The object of the Laboratory is to establish the principles and extend the knowledge of mechanical engineering science so as to provide industry with the information it requires for the solution of its own particular problems. In order therefore that its work may be focussed on practical objectives of real value to industry (which may involve basic or applied research or, in suitable cases, development work), the Council has decided that the planning of the Laboratory's activities and the selection of research projects can best be under the control of a small body with a measure of executive authority.

The new Steering Committee will be under the chairmanship of Vice Admiral Sir Frank Mason, K.C.B., M.I.Mech.E., M.I.Mar.E., who is a member of the Research Council and chairman of the outgoing Mechanical Engineering Research Board.

The Committee's terms of reference are:—

(1) To be responsible to the Research Council for the selection of projects and for the allocation of effort to them, within the financial resources allocated to the Laboratory and such other limits as may from time to time be imposed by the Council.

(2) To report annually to Council, submitting a research programme for the following year.

The Committee, which will be a full committee of the Research Council, is empowered to set up specialist sub-committees to provide technical advice on particular fields of work.

X-Ray Image Amplifier

Improvements in recent years in apparatus and techniques, particularly the production of microfocus X-ray tubes, have produced radiographs of increasingly fine definition. Radiographic films and the intensifying screens used with them, have been developed to take full advantage of these advances, but until recently the fluoroscopic screen has lagged behind because the brightness of the picture produced was not sufficient to enable the eye to discern all the details present. Because of the safety factor, X-rays of greater intensity, which would produce a brighter image, could not be used.

The technique of fluoroscopy enables continuous observations to be made, and movements such as the beating of the heart can be seen quite clearly. In normal fluoroscopy it is necessary to irradiate the patient during the whole period needed to assimilate the information contained in the image. With the X-ray image intensifier developed by Marconi Instruments it will only be necessary to irradiate the patient for the time required to form the image, which is of the order of 0·08 sec. This image can then be held on the viewing monitor (a direct viewing storage tube), without further radiation to the patient, until the next image is required. The finally developed equipment should enable a reduction in patient dose of up to 25 times.

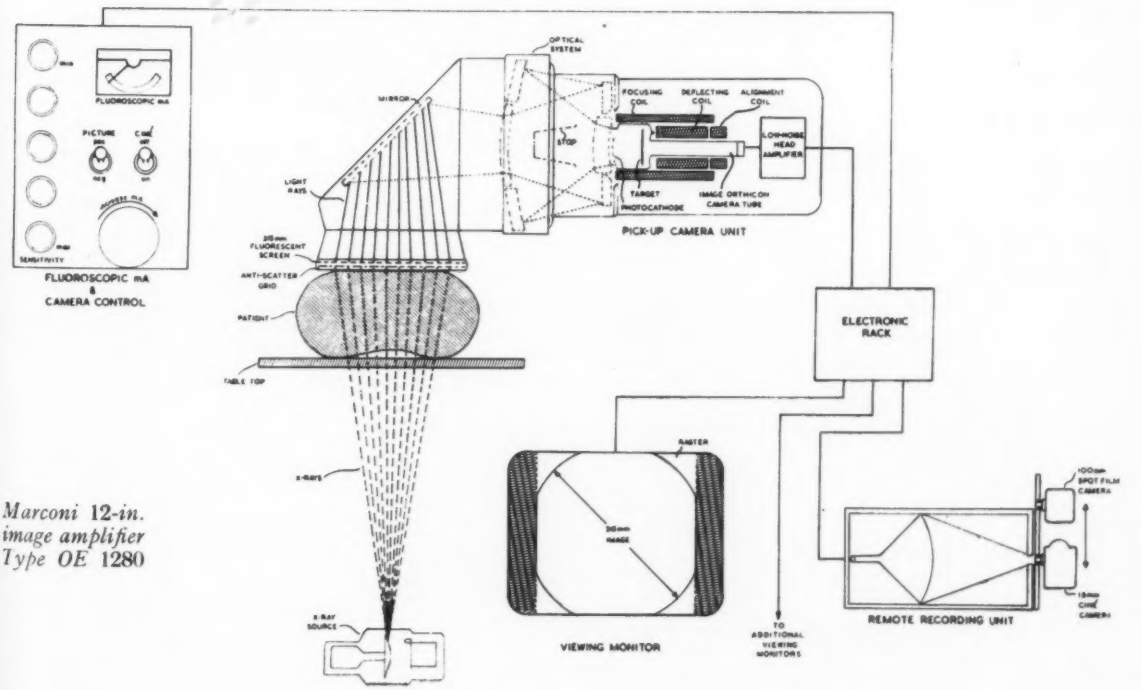
By using a slow repetition rate, a stroboscopic view of moving body parts can be obtained.

A further important function of this apparatus is the provision for remote cine radiography and serial radiography, and it will be possible for the first time to produce a continuous record of the large fluoroscopic image at doses tolerable to the patient.

After passage through the patient, the X-ray beam impinges on a high definition fluorescent screen contained in the base of the camera unit. The light from the fluorescent screen is reflected by a mirror into a highly efficient lens system and thence to the photocathode of a specially designed image orthicon camera tube. The design of the optical system is such that the total flux loss has been reduced to about 8%. Following electronic amplification the image is then reproduced on the screen of the monitor. It is not until this stage is reached that the human eye has to view the fluoroscopic image, and since the brightness level has been considerably increased electronically, the eye is allowed to work at maximum efficiency.

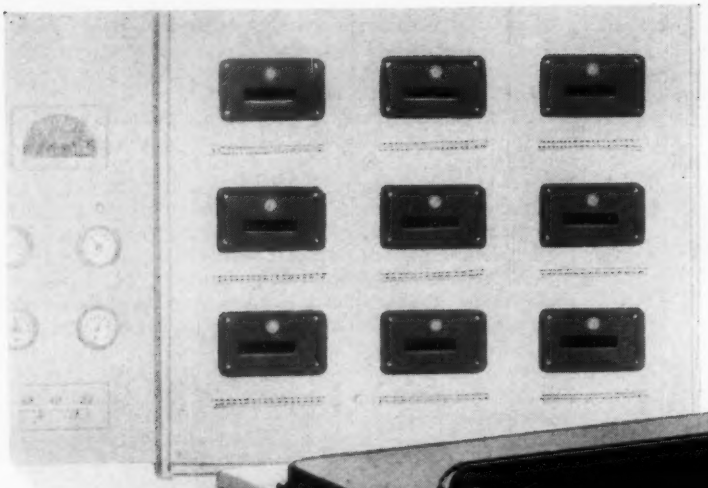
The final image is displayed on a rectangular cathode ray tube with a 17 in. diameter screen. The actual image occupies the central area of the screen being 11 in. square with rounded corners 12 in. in diameter. This size is identical with the size of the original fluorescent screen contained in the camera unit so that, although the image has been increased in brightness, the physical size remains unaltered. To give the radiologist some additional control over the quality of the final image the monitor is fitted with a brilliance and a contrast control. Also the final image may be made either positive or negative by the operation of a switch.

A further feature of the system is that several monitor screens can be fed with information at the same time thus permitting independent viewing by an almost unlimited number of observers.



Marconi 12-in. image amplifier Type OE 1280

Circle 51 for further information



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This counter embodies all the well tried features of our Type 100 Electric Counters, plus electric reset. This form of reset is particularly useful where a number of counters are required to be reset at the same time.
Coils for both resetting and counting can be supplied for operation on the following voltages:—
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Mullard High-speed Counting Tube

MULLARD LIMITED have announced the introduction of a trochotron high-speed decimal stepping tube, for use as a counter or selector at speeds up to 1 Mc/s.

The tube, called Type ET51, is switched by a negative signal, and provides a constant-current output of 5·5 mA, sufficient to drive a cold cathode decimal indicator (such as the Mullard Z503M) and compatible with the input requirements of direct read-out digital indicators.

Its chief uses will be in nucleonic scalers, decimal computing equipment, and electronic switching circuits. In these and similar applications, one ET51 with its relatively simple circuitry can replace a number of conventional valves or transistors and their associated components.

The trochotron is a vacuum device which makes use of crossed electric and magnetic fields to form a beam of electrons between a thermionic cathode and any of ten groups of three electrodes mounted radially about the cathode. The electric field is provided by the inter-electrode potentials within the tube and the magnetic field by a cylindrical permanent magnet fitted externally around the glass envelope.

Each group of electrodes consists of a spade, which forms and locks the beam in position; a target, which makes the beam available as a constant current output; and a grid, for switching the beam from one spade to the next. When power is first applied, all spades will be equally positive with respect to cathode and, due to the action of the magnetic field in preventing electrons reaching the electrode-groups, the tube will be in a "cut-off" condition, with no beam formed. However, if the potential of any spade is reduced, by means of a high-speed pulse or a d.c. voltage, the beam will form on the electrode group associated with that spade, and an output will appear on the corresponding target.

Once formed, the beam is held in this position by a combination of the spade series resistance and spade current until it is stepped to the next position by lowering the voltage on the associated switching grid.

Since only the grid in its immediate vicinity will affect the beam, the grids are connected internally in two groups: the odd-numbered grids in one, the even-numbered in the other. This makes it possible to use a d.c. input for switching and still obtain single position stepping, thus avoiding the necessity for a pulse of critical width.

The output characteristic of the trochotron is similar to that of a pentode valve, and in the ET51 over 80% of the beam current appears in the output, the remainder being used to form and lock the beam.

The ET51 is mounted on a special 26-pin (B26A) base comprising ten connections each for spades and targets, two grid connections, and heater and cathode connections. It has an overall seated height of 3·3 in. (84 mm) and an overall diameter of 1·74 in. (44·2 mm) including the magnet and special protective caps.

Typical operating conditions for the tube, which is a direct replacement for the American Services Type 6700, are:

Spade:—Voltage, 100 V; Current 1·0 mA; Load resistor, 100 kilohms. Target:—Voltage, 100 V; Output current, 5·5 mA. Grid voltage, 25 V; Input pulse, −60 V; Cathode current, 6·5 mA. Heater, 6·3 V, 300 mA (a.c. or d.c.).

Circle **1** *for further details.*

Sensitive Valve Voltmeter

The Type 614C sensitive valve voltmeter is a compact, portable instrument for the measurement of voltages from 80 μV to 300 V at frequencies between 5 c/s and 100 kc/s. It is possible to measure alternating voltages with superimposed direct current, although a combined peak level of 1,000 V should not be exceeded.

Type 614C sensitive valve voltmeter

The basic circuit comprises a high-gain amplifier which feeds a full-wave rectifying indicating meter through an attenuator. The two stages of this attenuator—one at the input and the other separating the twin amplifier stages — are both switched by a 13-position range switch to obtain full-scale deflections of 300 μV, 1 mV, 3 mV, 10 mV, 30 mV, 100 mV, 300 mV, 1 V, 3 V, 10 V, 30 V, 100 V, and 300 V. The alternator stage following the first amplifier section is brought in first to improve the signal-to-noise ratio at higher input levels. High calibration accuracy and stability are ensured by the application of negative feedback over the two amplifier stages and by the incorporation of a stabilised h.t. power supply.

The meter is calibrated in r.m.s. values for a sinusoidal input, the indications representing the full-wave average value. The logarithmic voltage scale gives equal reading accuracy (better than ±2% of indication with a sinusoidal input) for all voltages. The frequency error is less than ±3% from 5 c/s to 100 kc/s. In addition to the thirteen normal voltage ranges, an auxiliary linear decibel scale gives a range from −80 to +50 dB with reference to 1 V.

An output jack is provided for monitoring the signal or to enable the instrument to be used as an amplifier with a gain of up to 88 dB. When used in this way, the output is approximately 8 V r.m.s. at full-scale deflection into a minimum load of 10 ohms. The source impedance is roughly 20 ohms.

The meter draws some 40 W from 110 V or 200-250 V, 50-60 c/s power supplies. The input impedance is approximately equivalent to a resistance of 10 megohms in parallel with a capacitance of 25 pF up to the 10 mV range and with about 10 pF on higher ranges. Overall dimensions are 6½ × 10 × 9½ in. high and the weight is 10 lb.

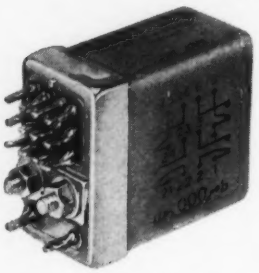
Circle **2** *for further details.*

Metrawatt Insulation and Earth Testers

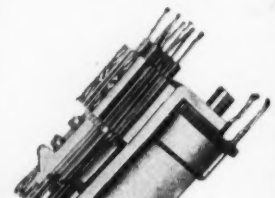
THE Metrawatt range of insulation and earth testers has been designed to meet the need for portable, accurate, robust, yet inexpensive instruments for both indoor and outdoor installation and maintenance of cables, wiring and equipment.

Every possible effort has been made to

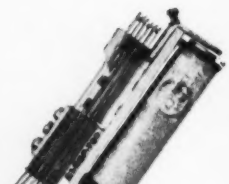
Circle **52** for further information



Miniature Sealed Relay

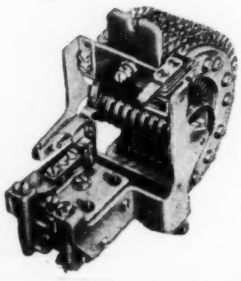


Major Relay
(B.P.O. 3000 type)

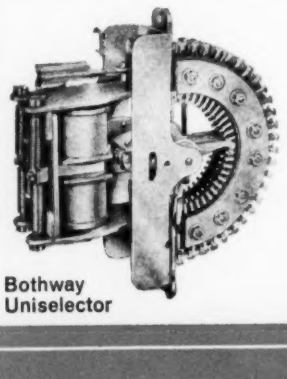


Minor Relay
(B.P.O. 600 type)

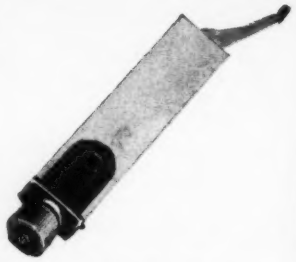
High-Speed
Miniature
Uniselector



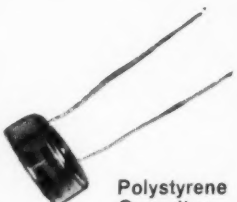
Heavy-duty
Uniselector



Bothway
Uniselector



Tension Gauge



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Metrawatt insulation and earth tester

reduce the weight and size to an absolute minimum yet the accuracy and range are still comparable and in many cases superior to those of larger instruments.

The hand generator, which is easy to turn, has fixed windings, the permanent magnet armature rotating in conjunction with an efficient centrifugal governor. A contact rectifier is used and there are therefore no carbon brushes to replace. The design is such that there is negligible wear and extreme reliability. Accurate output voltages from 100 V to 5,000 V d.c. are available in conjunction with resistance ranges from 0·1 Ω to 4,000 MΩ.

A completely sealed moving-coil meter is incorporated having an anti-parallax mirror and knife-edge pointer. The accuracy of the instrument is ±1%.

A special three-terminal model for measuring earth resistance is also available. The instrument covers from 0-2 Ω to 0-10,000 Ω full scale.

All models are housed in strong, pressed steel cases measuring 7¼ in. × 3¼ in. × 5 in. and weigh only 4½ lb.

The prices range from £21 10s. 0d. to £54 0s. 0d. Early delivery.

Circle **3** *for further details.*

Direct-reading Impedance Comparator

THE Type 304 impedance comparator has been designed for the rapid production testing of resistors, capacitors and inductors. Due to the ease of operation, up to 2,000 components per hour can be checked —the percentage deviation of the value from a known standard being directly indicated on a 5 in. meter scale. A special micro-switch is employed to enable speedy switching from impedance to phase angle measurement.

The instrument can be used in conjunction with standard decade resistor or capacitor boxes to obtain accurate measurements of resistance and capacitance.

The winding of coils, transformers, chokes and similar inductances can be tested for shorted turns, number of turns, etc.

Specification

Component ranges: Resistance, 10 Ω to 5 MΩ; Capacitance, 100 pF to 10 μF; Inductance, 2 mH to 100 H.

Component tolerance scales: −1·3% to +1·5%; −6% to +8%; −22% to +32%.

Accuracy of component comparison is better than 0·03% for deviations close to zero, with zero phase angle difference between standard and unknown. Better than 3% of indicated deviation at full scale deflection.

Dimensions: 8¼ in. × 13 in. × 12 in.

Weight: 21 lb.

Stability: The zero is independent of the supply voltage. 10% variation of mains voltage causes less than 3% change of indication.

Power supply: 110 V and 200-250 V, 50-60 c/s, 40 W approximately.

Circle **4** *for further details.*

D.C. Amplifier

THE amplifier can be supplied in chassis form or in a weather-proof sheet steel case and has plug-in ranging units which cover standard ranges between two milliamps output for five millivolts input and 15 milliamps output for 65 millivolts input; instruments requiring an input of only two millivolts for two milliamps output are available to special order. It is potentiometric in operation and responds to a change as small as one microvolt at the input; no measurable change in the output occurs when a resistor in series with the input is varied between zero and 50 ohms or even higher. The output load resistance can be as high as 3,500 ohms.

The completely transistorised electronic circuits operate at radio frequency, and the overall performance is determined largely by a highly stable resistor in a feedback circuit; thus errors due to unstable power supplies or to a "chopper" are avoided. Only two transistors are employed.

The instrument consumes only a few milliamperes from a 12 volt d.c. battery or power supply unit and supply variations as great as ±15% cause an error of only ±0·05% in the output. The transistors generate no heat so that long term stability without attention over several years is achieved.

Circle **5** *for further details.*

Rubber Conduit Strip

The non-slip face holds the flexible conduit strip safely to the floor, the specially designed wedge section prevents tripping as well as damage to leads and equipment. Trolleys and vehicles may safely be driven over the protective strip. The tunnel in the strip is wide enough to take the widest flat cables. The strip is priced at 3s. 9d. per foot retail, and 2s. 8d. per foot wholesale.

Circle **6** *for further details.*

Furnace Atmosphere Control

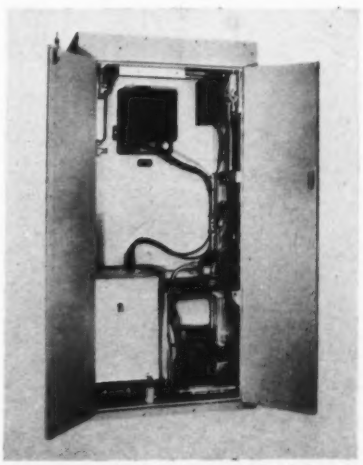
A SELF-CONTAINED cabinet, fully piped and wired, incorporating record and control functions and providing a precise method of controlling furnace atmospheres, based on the simple relationship between dewpoint and carbon potential, is now available. The unit is eminently suitable for atmosphere control on a wide range of heat treatment processes including gas carburising, carbonitriding and bright annealing.

In operation, a gas sample of about 20/30 ft³/hour is drawn from the generator or furnace, and led via a cooling coil into a sample chamber in which a Dewcel is mounted. The whole of this assembly rests in a cooling bath filled with water. For dewpoints above 12°F (low carbon potentials) running mains water is adequate to lower the sample temperature to within the Dewcel operating range. For dewpoints down to −5°F (high carbon potentials) the bath requires refrigeration to lower the sample temperature to about 35°F. Lower dewpoints can be measured by the installation of a compressor in the sample line which has the effect of elevating the dewpoint and makes measurement practical down to −40°F atmospheric pressure base.

The Dewcel humidity sensitive cell consists essentially of a thermometer bulb inside a thin walled metal tube covered with a woven glass tape which is impregnated with a hygroscopic salt. Two parallel gold wires, connected to a 25 volt a.c. supply, are wound over the tape and the whole is protected by a perforated metal guard. When the salt absorbs moisture from the surrounding atmosphere it becomes an electrical conductor and current passes between the two wires, thereby raising the Dewcel temperature until equilibrium is reached. This equilibrium temperature is measured by a liquid expansion thermometer or a resistance bulb, and is recorded as dewpoint.

The cabinet contains a dewpoint recorder complete with the ancillary equipment necessary to measure dewpoints down to −5°F. In this case, the sample gas is mechanically extracted and led, via a ceramic filter, into the cooling coil and sample chamber where it is presented to the Dewcel surface. The temperature of the cooling bath is maintained at 35°F by a refrigerated coil. After passing through the system the gas is burnt off on a stainless steel burner on the outside of the cabinet.

Where control is fitted, a proportional plus reset controller is used to operate a pneumatic control valve which alters the air/gas ratio to the generator, or in the case of propane enrichment at the furnace, throttles a valve in the propane line.



Self-contained unit for control of furnace atmosphere

The free standing self-contained cabinet is attractively presented in a choice of stove enamelled colours, and measures 80 in. high by 38 in. wide and 24 in. deep. Dual, triple and other multiple cabinets are available.

Circle **7** *for further details.*

Gas Torch for High-temperature Welding

THE torch uses coal gas at normal mains pressure; this, it is claimed, reduces operating costs to approximately one third those of an oxy-acetylene torch.

A preheater raises the temperature of both gas and primary air to 750°C before they reach the mixing chamber. The resultant flame cannot be blown out and continues to operate even when the torch is played into an inert atmosphere. The inner section of this flame, approximately 4-5 cm long, has a temperature greater than 2,000°C. It will readily melt 1 mm platinum wire.

When the torch is used for silver soldering stainless steel there is a noticeable reduction in distortion. It has been successfully applied to soldering and brazing high magnesium alloys and also for autogenous welding of brass, aluminium and Al-Mg alloys.

Circle **8** *for further details.*

Clip-on Ammeter for Measuring Current in Railway Electrification

THE introduction of a new clip-on ammeter by Ferranti Limited for measuring current in railway electrification has extended the range of the Company's clip-on instruments.

This instrument, which is the first of its type to have been developed specifically for railway applications, is basically similar to the conventional Ferranti clip-on ammeter operating on the split-core current transformer principle, except for the triangular-shaped core which is necessary so that all standard types of railway lines can be easily embraced and measurements taken quickly and efficiently by linesmen.

Clip-on ammeter

Six separate ranges are obtainable on the instrument, which are controlled by a thumb-operated selector switch. These are 0-10, 25, 50, 100, 250 and 500 amp a.c. Accuracy is within 5% of full-scale on all ranges.

Circle **9** *for further details.*

Cam Block Electrical Connector

SCREWLESS, lugless, positive locking terminal block connectors using a cam action will be manufactured in the U.K. shortly. The connectors are available with two to twenty stations in 15, 20 and 30 amp capacities. The dielectric strength is 3,000 V between terminals, 4,500 V between terminals and base

Circle **10** *for further details.*

Multi-point Potentiometer Recorder

A NEW potentiometer recorder of high quality, the Type 1550, is now available from Ether Ltd. Completely self-contained, it can record up to eighteen independent points on an 11 in. wide, easy-to-read chart, and offers seven variable chart speeds. Numerals, symbols and six variable colours can be printed, so that each record on the chart can readily be distinguished.

Measurements can be made of such variables as temperature, speed, strain, pressure, hydrogen ion (pH) and other quantities that can be expressed in electrical signals. Temperature can be measured through thermocouples or through the Ether "Forgemaster 60" radiation pyrometer.

The new potentiometer recorder is available in a wide selection of standard scale ranges

The instrument is maintained in a permanently standardised condition by a voltage stabiliser unit which can maintain voltage across the bridge to better than 0·1% during a 20% change in supply voltage. However, as an additional refinement to permit an occasional check to be carried out, a manual calibration check unit is also incorporated.

Other features include a specially-designed amplifier (the components of which have undergone extensive tests and selection), a full-scale printing carriage which takes only two seconds to travel across the 11 in. calibrated chart, and a simple plug-in unit for easy range changing.

The instrument is contained in an all-welded steel case, heavily sealed against dust and moisture.

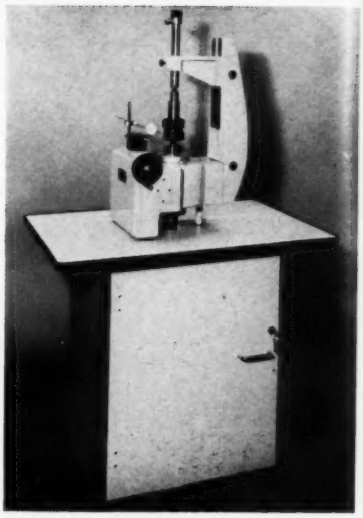
Circle **11** *for further details.*

Bench Lead Measuring Machine

THE Goulder bench lead measuring machine is designed for checking the lead of helical gears of sizes associated with the automobile, aircraft and machine tool industries. Both internal and external gears can be checked and the standard machine incorporates centres so that shaft gears can be accommodated.

All castings are of stress relieved Meehanite metal, and the live spindle incorporates high precision taper roller bearings.

The generating mechanism incorporates a sine bar and steel tape device and the setting is made by slip gauges.



Bench lead measuring machine

Errors may be observed from an indicator or from a recorder.

The price of the basic instrument is £562 10s. 0d.

Circle **12** *for further details.*

Speed Regulator for use with Compressed Air Cylinders

BALDWIN INSTRUMENT CO. LTD. announce that they are now in production with a new improved speed regulator, for use with their compressed air cylinders. These new units are an improved development of the earlier micrometer type, and have a regulation of at least three times that of the previous model. The bore sizes are $\frac{1}{4}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in. and 1 in.

The unit is made from Duralumin, which is anodised. A friction device incorporated in the body of the regulator prevents the micrometer adjustment from being disturbed by vibration.

The regulator screws directly into the exhaust ports of the directional control valve, and thereby throttles the escape of air from the exhaust end of the cylinder. Where steadiness of motion is required, this method of speed regulation is to be preferred.

All regulators are screwed B.S.P. (parallel series), to conform with nominal bore size, and it is recommended that they should be sealed to the valve body by the use of soft metal washer or bonded seal. The maximum working pressure for all these regulators is 150 p.s.i.

Delivery can be effected in seven days.

Circle **13** *for further details.*

Miniature Wire-wound Potentiometer

THE Type 8 model, 3-gang wire-wound potentiometer measures $\frac{3}{4}$ in. in diameter, has a shaft diameter of 0·078 in., and weighs 0·5 oz.

Resistance values range from 1 to 25 k ohms, the tolerance being ±5%. Power rating is 1 watt with no derating up to +70°C. Laws available include linear, sinusoidal and non-linear functions, the standard linearity tolerance being ±0·3%, but this can be made as low as ±0·1%.

Miniature wire-wound potentiometer

The main aim in the development of the new potentiometer has been to produce an extremely small unit with the maximum resolution and linearity and lowest starting torque possible, coupled with reliability of operation.

The considerable reductions in size and weight which have been effected have been achieved by winding a much smaller toroid. The toroid, which is made of anodised aluminium, is housed in a stable plastic moulding contained in a machined aluminium body. The shaft is mounted in precision miniature ball-races, which, coupled with low wiper pressure, ensure a low operating torque of the order of 0·5 g/cm.

The wiper or sliding contact is formed from precious metal wire, a double contact being used for greater reliability. Wiper pressure is of the order of 1 g.

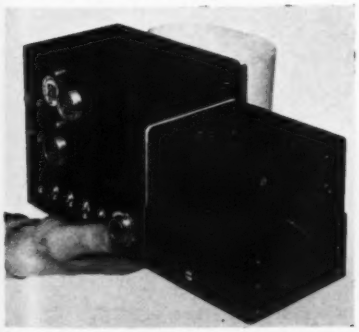
It has been designed to provide analogue conversion from mechanical rotation to an electrical signal, and is most suitable for use in flight simulators, analogue computers generally and for data transmission, particularly in aircraft.

Circle **14** *for further details.*

SFIM U.V. Recorder

THE recorder measures 107 × 147 × 289 mm (4·2 × 5·8 × 11·3 in.) and weighs less than 10 pounds. It is in one complete self-contained unit requiring only an external power supply of 50 volts d.c.

Up to six continuously varying and two discontinuous parameters may be recorded against an accurate one second time-base. Twenty feet of 60 mm wide paper can be accommodated in the recorder itself. If a longer duration is required, there is an external clip-on cassette which can contain a complete 100 ft roll of recorder paper.



SFIM u.v. recorder

At present there are three types of recorder from which to choose, differing only in the speed of the paper.

The recording principle is conventional in that each of the recording elements is provided with its own mirror, or series of mirrors, which is displaced under the influence of the quantity being measured. The image of the light source is reflected by the mirror in such a way that a spot of light traverses the length of the recording aperture for the full-scale range of the element. Thus the traces may cross one another and thereby achieve full deflection across the recording paper.

Circle **15** *for further details.*

Budenberg Gauge Tester

THE "Ranger" is a dead-weight pressure gauge tester for pressure readings between 10 and 8,000 lb/in².

A National Physical Laboratory Report on the diameter, roundness and straightness of the high pressure piston is supplied with each unit together with a certificate guaranteeing pressure reading accuracy within 0·03%. The degree of accuracy is determined by a comparison test under pressure, between the high and low pressure piston/cylinder assemblies of the piston unit supplied and a piston/cylinder assembly specially calibrated by the N.P.L.

A patented priming pump, combined with the oil reservoir, quickly fills the system and applies an initial pressure up to 150 lb/in². Pressure can be rapidly increased by a few turns of the main screwpress, a hard-wearing unit fitted with a ball thrust and ground thread screw.

Operation of the tester is simplified by the provision of a patented dual piston unit, with piston sizes of $\frac{1}{8}$ and 1/80 sq. in. for low and high pressure ranges respectively. The changeover from one range to the other is made automatically as pressure is increased or decreased by the screwpress. A ratio of 10 : 1 can be obtained without changing the weights, thus enabling a pressure gauge to be checked at both ends of the scale with a minimum of effort.

Adaptors for all common types of standard and flush-mounting gauges, and other accessories, including pointer remover, punch and spanners, can be supplied.

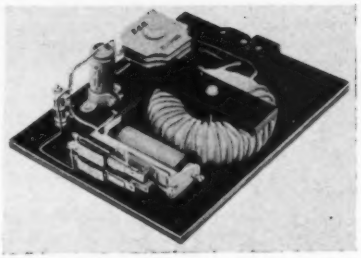
Circle **16** *for further details.*

Automatic Load Indicator Unit Type ALI

THE load indicating unit Type ALI operates when a.c. current is passing through a choke in the unit. Voltage drop across the choke is utilised to operate a relay with the switching capacity of 5 amp at 230 V a.c.

The unit is usually connected in series with an a.c. load on mains voltage. A small a.c. current saturates the choke and operates the unit. A range of chokes is available to withstand quite heavy maximum currents. The a.c. voltage drop across the choke is quite low and does not exceed 4 V at 100 amp.

Control units ALI consist essentially of a quickly saturated choke, rectifier, condenser, relay, terminals and mounting board. Sets of components without mounting board can also be supplied if required.



Automatic load indicator unit, Type ALI

Units Type ALI are supplied for maximum loading of 20 amp, 35 amp, 50 amp, 75 amp and 100 amp at 250 V a.c. The minimum load detected by the unit can be as low as 60 W at 250 V a.c. Special units can be supplied for operation on close pull-in drop-out ratio or for detection of very low currents.

The overall dimensions are 7 × 9 × 3 in.

The unit can be supplied in sheet metal or cast aluminium enclosure.

Prices range from £6 5s. 0d. and delivery is two to four weeks.

Circle **17** *for further details.*

Transistorised Conductivity Bridge Type BCI

THIS transistorised conductivity bridge operating at high frequency from a long-life dry battery covers the range of 0·5 μmhos to 1 × 10^6 μmhos in six ranges.

The a.c. measuring bridge is energised at a low potential by a 1,500 c/s transistor oscillator. This high frequency is used to overcome inaccuracies which would otherwise occur at high solution conductivities.

In use, bridge balance is shown by maximum deflection of the indicator meter. The conductivity of the solution is then read from the large calibrated dial. By using this null-point method variations in battery voltage or transistor characteristics do not affect the accuracy of measurement.

The bridge is suitable for use with most types of conductivity cell. If the cell has a constant other than unity, the actual solution conductivity is obtained by multiplying the bridge reading by the cell constant.

Transistorised conductivity bridge

A built-in variable capacitor is provided to balance out cell and cable capacitance which would otherwise give a flat balance point.

The price complete with dip type conductivity cell is £72 10s. 0d. and delivery can be given within 3/4 weeks.

Circle **18** *for further details.*

Newmarket Transistors

The "Noodle" power transistor has been developed to operate at currents higher than 3 amp. It utilises a junction geometry of a new kind to ensure high emitter efficiency at high currents. A range of four "Noodle" power transistors are available. They possess good beta fall-off characteristics, and can be used at up to 15 W dissipation on a 50 in^2 heat sink.

Two new switching transistors are available with rise times in the hundreds of mμ sec range. They have a basic 10 V rating but can be supplied up to 20 V.

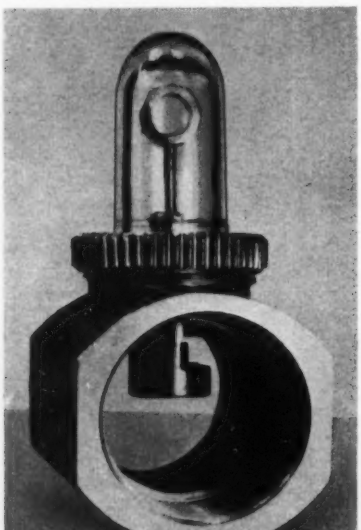
Circle **19** *for further details.*

Large Size Variable Flow Indicators

DEMAND on the part of many customers has urged Walker, Crosweller & Co. Ltd., Cheltenham, to extend the range of their Arkon variable flow indicators. These instruments can be adjusted for high or low velocities of flow and now include sizes 1¼ in., 1½ in. and 2 in. in addition to ⅛ in., ¾ in. and 1 in.

The principle of cartridge construction, as applied in these Arkon instruments, has met with immediate acceptance in preference to other methods. With Arkon indicators the complete cartridge assembly is interchangeable between the different sizes. The spindle impeller assembly, which is fitted in a cartridge housing, is easily removed and reset for the required flow range.

The Arkon indicator itself is simple and reliable and shows at a glance whether flow is taking place. A chromium plated ring at the top of the spindle under a toughened glass dome stops spinning if the flow stops.



Arkon variable flow indicator

Arkon variable flow indicators are used to indicate the flow of water, lubricating oil, cooling oil and other liquids.

Circle **20** *for further details.*

Air-conditioning Electronic Equipment

A THREE-AND-A-HALF million dollar microwave communication system for the United States Air Force in Great Britain will be protected from the effect of humidity, condensation, and overheating by automatic heating, cooling and dehumidification controls.

Thermocontrol Installations Company Limited will install hermetically sealed refrigeration units with automatic control by modulating thermostats as well as high-limit humidity control, for the semi-trailer vehicles.

Each unit will contain hermetically sealed motor compressors, refrigeration condensers and evaporators, with propeller fans and air heaters. All equipment will be controlled by thermostats and humidistats.

A feature of the Thermocontrol equipment is their system of interlinking the de-humidification, heating and cooling controls in the specially designed control panel, avoiding overrun and waste of power.

The control system will include a TIC step controller for graduated and sequential control of the electrical heater batteries and refrigeration condensing units. It incorporates a shaded - pole reversing motor, which transmits its power through a gear train to the final drive shaft. This rotates a camshaft providing sequential operation of a series of micro-switches, automatically controlling a battery of heaters and coolers.

The humidistat HF3 is being used because of the high sensitivity of its control mechanism. Composed of 150 strands of hair, the element causes control action at the slightest change in humidity. A tension device prevents the hair strands from being damaged by mechanical strain.

Accurate temperature control in the vehicles is ensured by the TZP thermostat, a vapour-pressure type controller having throttling band adjustment in addition to the main setting.

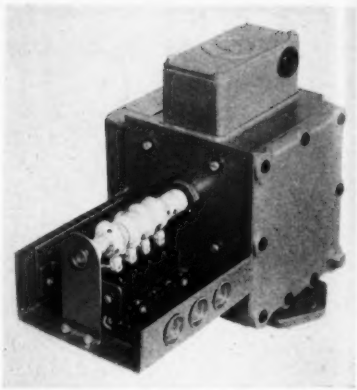
The necessary communication system will be supplied by Marconi's Wireless Telegraph Co. Ltd., the Automatic Telephone and Electric Co. Ltd., and the Telephone Manufacturing Co. Ltd.

Circle **21** *for further details.*

Proportional Temperature Controller S.R.I

THE C.N.S. saturable reactor type proportional temperature controller has been produced to meet the need for a temperature controller of simple operation, with no moving parts which will provide close control of furnace temperature without the additional cost of the variable mains transformer, the mains shunt resistance and the relay which are standard in most furnace control equipment.

The controller is operated by a resistance thermometer whose change of resistance with temperature is used in a bridge system to give a continuously variable current which governs the output of a saturable reactor or transductor. This



TIC step controller used in air-conditioning electronic equipment

controlling current varies from 5 to 100 milliamp d.c. with a load of 2,500 ohms maximum.

The controller is used in conjunction with a reactor of suitable size for the particular furnace (generally ½, 1, 1½ or 2 kVA). Used with a 1 kVA reactor the power supply to a furnace can be set from 200 VA to 1 kVA by adjustment of the bridge precision potentiometer. After this setting any variations in the resistance of the thermometer due to temperature changes in the furnace will readjust the current to maintain constant temperature. A 1% change in absolute temperature is sufficient to swing the control current from its maximum to its minimum value and temperature errors which would occur without the controller are reduced by a factor of 600 approximately, whether they are due to mains voltage variations, ambient temperature changes or varying thermal constants. This means that the overall effect of a mains voltage change of 5% on a furnace operating at say 700°C can be reduced to within + or −0·2°C.

The controller has an additional facility in that it has compensation for mains voltage variations which comes into effect instantly, thereby anticipating the signal from the resistance thermometer and stabilising the furnace current. Because of this compensation transient errors in temperature due to thermal lag are reduced to a minimum.

Saturable reactors are available with the controller which will enable almost any furnace or oven to be run directly from the mains supply whether 110 or 240 volt and the need to switch or control all or any part of the current to the furnace is completely unnecessary with consequent saving on installation costs, complexity and liability to failure.

Circle **22** *for further details.*

The Condiognom

A NEW kind of pocket dosemeter of the fountain-pen type is available for the protection of personnel who come in regular contact with ionising radiation in the course of their duties.

The device is known as the "Condiognom" and one feature of it is that it eliminates interference with the readings on the part of the wearer as he is unable to take a direct reading of the dose. The

Condiognom

reading is done at a central point by means of a mains-operated charging and measuring device which is suitable for use with any number of dosemeter chambers.

The Condiognom has two (twin) condenser chambers which are screwed together to form a very light single unit of the approximate size of a fountain-pen. They are provided with a clip and are not separated except for charging and measuring. Each chamber is hermetically sealed and operates independently. The measuring range of the larger chamber is 0-100 milliroentgens and thus adequately covers the maximum permissible daily dose for personnel engaged in radioactive work. The measuring range of the smaller chamber is 0-1,000 milliroentgens and this chamber is designed to register any quantities received when the larger chamber is completely discharged.

The walls of the chambers are transparent to radiation and the centre electrodes are amber-insulated. The chambers are charged separately before being issued to the personnel. Ionising radiation partially discharges each chamber and the loss of charge is determined by measuring the chamber voltage electrostatically. The meter indicates directly in milliroentgens. Air wall materials are used in the chambers and the readings are therefore practically independent of radiation energy from 50 keV to gamma rays of cobalt and radium.

The twin chambers of the Condiognom thus allow the survey of not only the normal radiation dose received by the personnel but also the measurement of the extent of an occasional overdose. It is possible therefore in such a case to take the person concerned off radiation work for a known period of time without risk and without causing alarm.

Circle **23** *for further details.*

Vibrating Cylinder Pressure Transducer

THE Solartron Electronic Group Ltd. have concluded with the Svenska Flygmotor Aktiebolaget a manufacturing and marketing agreement of world-wide coverage (except Scandinavia) for a new "Vibrating Cylinder" pressure transducer.

The "Vibrating Cylinder" is small, accurate and extremely robust as a pressure transducer. The variable frequency output signal makes it especially suitable for magnetic tape recording, particularly with the Solartron data recording equipment; also for analogue-to-digital conversion by pulse counting. The equipment which uses the signal from the transducer can be located miles away from the point of measurement, without loss of accuracy.

The pressure sensitive element of the "Vibrating Cylinder" pressure transducer is a mechanical vibrating system, whose natural frequency is dependent upon the applied pressure. This vibrating element determines the frequency of an electronic feedback oscillator thus providing an output voltage of constant amplitude but with a frequency which varies with the pressure applied. The transducer was developed as a part of a system for recording ramjet data on magnetic tape, during flight.

For this purpose a transducer with a variable frequency output was found to be the most suitable. The variable frequency signal is easily convertible to digital form for further treatment in a digital computer.

Provisional Specification

Input pressure ranges: 25 p.s.i., 50 p.s.i., 100 p.s.i., 600 p.s.i.; Overload limit: All transducers tested to 100% overload; Linearity and hysteresis: ±1·5% (terminal linearity); Fundamental response: Parabolic law curve. Accuracy of repeatability on this curve ±0·1%; Excitation: Miniature 6 V transistor feedback amplifier, built on a printed circuit and Epoxy resin encapsulated; Acceleration response: Vibratory: 10 G up to 2,000 cycles per second. No effect upon the output signal measurable. Static: Axial sensitivity, 0·015% of full range for 20 G; Thermal coefficient of sensitivity: 0·02% of pressure range per degree C; Size: 1·5 in. diameter, 2·5 in. long (381 mm × 635 mm); Weight: 2 oz (56·7 grams).

Circle **24** *for further details.*

Transipack Model 707

FOR applications where hermetically-sealed units are not required, a universal converter has been designed. The toroidal transformer carries a number of taps, which enable selection of output voltage in steps of 50 volts over a range of 50 to 550 volts. A selenium contact cooled bridge rectifier is normally supplied for lower voltages; for higher voltages other rectifiers may be employed if so desired.

The Transipack is a semi-conductor converter housed in a diecast alloy box. The feature of Transipack 707 is the provision of spare space for input and output filter components, as well as rectifier, other than the miniature selenium bridge normally provided. All components are easily accessible and replaceable.

The lid and the cast box form a transistor heat sink. The circuit incorporates automatic overload protection in an event of short circuited load. The input and output connections are available on robust terminals.

Specification

Input: 12 V d.c.; Input polarity: Negative input employed; Output voltage: 50-0-100-200-300-400-500 volts nominal; Rectifier: Unless otherwise requested, miniature selenium, contact cooled bridge 250 V, maximum 75 mA, will be supplied; Load: 30 watts maximum; Switching frequency: 1,000 c/s approximately; Efficiency: 85% at full load; Ambient temperature: 55°C maximum; Mounting: Diecast box $4\frac{7}{16} \times 2\frac{7}{16} \times 1$ in. with tight fitting lid; Weight: 1 lb 15 oz; Price: £12 3s. 0d. Substantial reductions for quantities in excess of 50 units.

Circle **25** *for further details.*

Transistor Polarising Supplies

Two new units, PNI1034 and PNI1042, are available for polarising ionisation chambers used in the flux measuring channels of nuclear reactor instrumentation systems.

The h.t. output, from 400 to 600 volts, is derived from a transistor converter circuit and an alarm relay is provided which indicates failure of output or disconnection.

A number of polarising supplies are normally operated from a common low voltage secondary battery but individual miniature, sealed, secondary batteries could alternatively be mounted internally.

Circle **26** *for further details.*

Herzog Circulation Thermostats

A COMPREHENSIVE range of circulating thermostat baths of improved design is now available for temperatures of −50°C to 300°C. External circulation is provided by a detachable pump of high efficiency mounted above the fibre-glass insulated bath, the temperature being controlled to ±0·01°C by a mercury contact thermometer; electronic relays are available if required. The heat input can be preset in three incremental steps and an auxiliary heater provides accelerated heating up to the control temperature. The bath capacities vary from 2·5 litres to 40 litres, the largest having five apertures to accept beakers of similar vessels up to 15 cm diameter.

Models are available with internal illumination and an observation window for U-tube viscometers.

The Dia-thermostat eliminates resistance heating elements by directly heating the copper sulphate solution used as the bath liquid; in this manner very rapid heating and a temperature constancy of ±0·002°C is achieved.

Circle **27** *for further details.*

Herzog thermostat bath

Digital voltmeter, Type LM902

Digital Voltmeters

THE Type LM901 digital voltmeter will measure up to 99·9 V positive or negative d.c. in three ranges. An "add 10" facility extends this full-scale reading to 109·9 V.

Under normal operating conditions the LM901 continuously monitors the applied voltage, but a "sample" mode is provided which allows a front panel push-button or external relay contacts to give controlled "lock-out". This is particularly useful for periodically sampling the instantaneous value of rapidly varying signals which, in the LM901, will normally give a recycling display.

Specification

Resolution: 0·1% of maximum indication on all ranges.

Accuracy: Absolute ±0·25% of maximum indication on all ranges. This figure is governed by the long-term stability of the Zener diode used for reference purposes. If the instrument is standardised against an external reference, e.g., a Weston cell, a short-term accuracy of 0·1% of maximum indication is obtainable.

Reading or conversion times: The instrument takes 280 msec to change its indication regardless of how great or small the change.

Polarity discrimination: The instrument automatically accepts either polarity and indicates "+" or "−" by red or black background to the figures.

Print-out facility: Coded decimal information is available via a rear-mounted socket: output energisation 6·3 V, 1 W.

Sampling operation: Push-button or a remote relay contact closure enables a changing voltage to be "sampled" from time to time as desired.

Display: The three-digit projection type. The decimal point is included in the display, its position being controlled by the setting of the sensitivity range switch. Mains input: 110 to 220 V ±20 V, 50/60 c/s.

Overall dimensions: 6¼ in. high × 7¾ in. wide × 12 in. deep (17 cm × 20 cm × 31 cm).

Weight: 13·5 lb (6·2 kg).

Mounting: Provision for flush panel mounting for instrumentation panel schemes.

The LM902 is a four-window digital voltmeter of 0·1% accuracy and having five full scale ranges from 0·1599 V to 1,599 V. The LM902 digital voltmeter incorporates all those facilities described for the three-window LM901; in addition there is a variable dead-zone control for stabilising the reading on fluctuating inputs and up to 40 dB common mode rejection of 50 c/s at the input.

Smoothing: Approximately 20 dB and 40 dB rejection factors of 50 c/s components are available by use of the "Filter Tc" switch.

Dead zone control: Dead zones of 0·5, 1, 2 or 5 units are available by selection on the "Dead Zone Units" switch.

Polarity discrimination: By means of red or black background to the digits displayed.

Print-out facility: Two 50-way sockets on the rear to supply Printer or remote display (2 watts for Printer; 2 watts for remote display).

Resolution: 0·1% of maximum reading.

Reading time: 280 msec, regardless of reading change.

Mains input: 110 to 220 V ±20 V, 50/60 c/s.

Overall dimensions: 13 in. wide × 8 in. high × 13 in. deep (33 cm × 20 cm × 33 cm).

Weight: 30 lb approx. (14 kg).

These digital voltmeters are applicable in continuous reading tasks, such as in production test, monitoring of dynamic process experiments, permanent monitoring of system and instrumentation elements.

Circle **28** *for further details.*

Hollow Spindle Potentiometer

THE design of the spindle is such that the need for machining special flats and knob fixings, etc., has been obviated, all locations and fixings being achieved by bending or forming the hollow brass spindle to accommodate a polystyrene ring which, in turn, holds the brush gear. The limit stop and switch operating lug are also incorporated in the polystyrene ring.

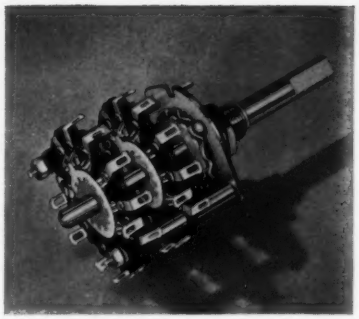
Another advantage of the new method of construction relates to the control knob. This merely needs a triangular plain hole slightly smaller than the spindle size to give positive location in three alternative positions. Conventional methods can, of course, be used. Furthermore, inherent flexibility in the spindle prevents straining of the control.

The bush and back plate are a one-piece zinc-based die casting, which gives great rigidity and accuracy of location. Insulation resistance in the potentiometer is extremely good by virtue of the use of polystyrene.

The new triangular spindle potentiometer enables Plessey to make available a potentiometer of moulded track construction at a price only slightly higher than the sprayed track type.

Circle **29** *for further details.*

Hollow triangular type spindle potentiometer



Oak rotary wafer switch, Model JK

Oak Rotary Wafer Switch Model JK

THE NSF-Oak Model JK provides up to 22 contact positions on a single section without the use of insulated back contacts. Multi-section JK switches will meet the most complicated circuit requirements in present day radio, television, instrument and electronic designs.

Electrical characteristics

Maximum working voltage, 300 V a.c./d.c.; Proof voltage, 1,000 V r.m.s.; Rating, 1 amp—28 V d.c. resistive load, 50 mA—300 V d.c., 100 mA—250 V a.c. r.m.s. non-reactive load; Current carrying capcity (not breaking), 5 amps; Contact resistance, less than 3 milliohms.

Maximum switching

One pole, 2 to 12 positions; 2 poles, 2 to 7 positions; 3 poles, 2 to 5 positions; 4 poles, 2 to 4 positions; 5 poles, 2 to 3 positions; 6 poles, 2 positions.

Contacts

Clips: Spring brass, silver plated. Spring quality silver alloy clips are available at additional cost.

Rotor blades: Hard brass heavily silver plated.

Circle **30** *for further details.*

Electro-magnetic Counters

IMPULSE counters manufactured by Elmeg are now available in this country at competitive prices.

Particular attention is drawn to the PZ Type, a long-life, low current drain, general purpose counter. These are for various voltages from 6-60 volts d.c., counting speeds 10, 25, and 50 impulses/second, either non-reset, mechanical reset, or combined electrical and mechanical reset. Type PZ can also be supplied for direct operation (no rectifier) on 220 volts a.c., for a counting speed of 10 impulses/second, either non-reset or mechanical reset only.

All counters are supplied in two forms, for flush panel or surface mounting and with 4, 5, 6, or 7 figures.

Circle **31** *for further details.*

"Neutrostat" Air Gun

THE "Neutrostat" air gun is designed especially for the removal of static attracted dust. Very similar in size and shape to any normal air gun, the "Neutrostat" will simultaneously blow off dirt and at the same time neutralise static charges on both the dirt and the article being cleaned.

Its main advantage, apart from ensuring the article is clean and completely destaticised, is that it considerably reduces

the manpower and time needed for such cleaning operations.

A number of guns can be energised from the same power supply, and any compressor developing up to 50 p.s.i. is suitable for the air supply. Some typical applications for this equipment are in the neutralising and cleaning of magnetic tapes before wind-up, plastic parts after moulding, leather after brushing, lenses and optical surfaces before packaging, plastic sheets before printing or silk-screening, vials and containers before filling, masonite wallboard after sanding and many surfaces before varnishing or painting.

It is expected that the nozzle part of the gun can be utilised for many other purposes such as the elimination of static in otherwise inaccessible positions, such as are encountered in feed piles.

Circle **32** *for further details.*

"Stabilec" Oven

THE "Stabilec" oven has recently been redesigned to bring it into line with modern requirements, and now provides a small, inexpensive oven suitable for many laboratory purposes.

The corrosion-resistant chamber, 12 in. × 12 in. × 14 in. high, is available in either electro-tinned mild steel or stainless steel. It is insulated from the outer metal case by a 2 in. thickness of slag wool and is fitted with two removable shelves, one of which forms the working floor of the chamber. The two heaters, which operate at black heat, are of the electric fire type for easy replacement, and are readily accessible on removing the floor of the chamber. The insulated door seals on to the front of the chamber by means of an asbestos gasket. A bent-stemmed thermometer is recessed in the door, the bulb of the thermometer being protected by a metal guard. Control of the chamber temperature is effected by a standard B.T.L. bi-metallic regulator fitted in a vertical position at the back of the chamber. The operation of the regulator is indicated by a pilot light. Accurate temperature setting over the range 30 to 200°C can be achieved by means of a control knob situated at the front of the oven and marked with an arbitrary scale of 0-100, used in conjunction with the separate calibration table supplied with each oven.

The oven relies upon normal convection heating, and a non-adjustable air vent is fitted to the top of the chamber. The overall size of the oven is 17 in. wide × 17½ in. deep × 24 in. high; the weight is approximately 32 lb. The oven is fitted with a 6 ft lead with open ends and can be supplied for operation on either 100/125 V or 200/250 V with a maximum loading of 600 W.

Circle **33** *for further details.*

Cabled Nylon Tubes

TYPICAL applications of cabled nylon tubes include the remote monitoring of processes and equipment in chemical plants and oil refineries by pneumatic or fluid-operated meters and other indicating devices.

The tubes, of which there may be 1, 3, 4, 7, 12 or 19 in a "cable", are identified by colour. They are laid up in electric cable fashion and sheathed overall with p.v.c. (polyvinyl chloride) or p.c.p. (polychloroprene). If desired they can be provided with steel wire armour protection.

No special type of support is required for these cabled nylon tubes; cable clips of tinned brass or corrosion-resistant metal are suitable for the smaller 1, 3, 4 and 7 tube assemblies, while BICC cast light-alloy claw-type cleats may be used for larger sizes and for groups of tubes.

These tubes are arranged so that they can be used with the standard fittings now generally available.

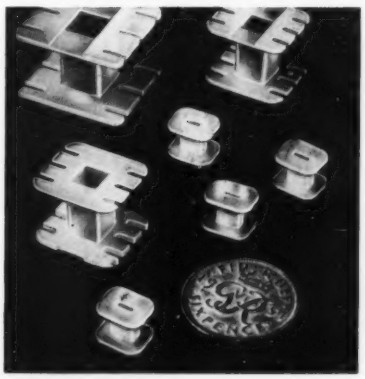
Circle **34** *for further details.*

Nylon Coil Bobbins for Miniature Transformers

A STOCK range of nylon coil bobbins has now been introduced to meet the demand of the radio and electronics industry for miniature transformers for printed circuit and similar work. Initial sizes are for square stacks of MEA 187 (RCL 450), MEA 262 (RCL 531) and MEA 218 laminations. The bobbins are designed with universal slots for bringing out leads and a hole flush with the inside of former for the first tap.

Nylon bobbins, being a one-piece construction, cut winding and handling cost and have excellent dielectric strength.

Circle **35** *for further details.*



Nylon coil bobbins

Croxtine General Purpose Anti-static Spray

THIS product—a self-spraying aerosol container—will prevent the problem of dust attraction on plastics, synthetic fibres and all other static prone materials.

Treated articles will remain cleaner due to a conducting layer left on the surface which dissipates any charges present and prevents any further charges being developed. The film is non-toxic, invisible, quick-drying and non-greasy.

Croxtine spray is effective on all plastics and will be particularly valuable in the treating of plastic components on television, radios, refrigerators and cosmetic goods. On television screens and cathode ray tubes it has a more utilitarian advantage, as it will prolong the tube life by reducing the dust collected and therefore the height at which the brightness control must be set. This spray will also be of advantage on instruments in preventing needle and dust attraction.

Croxtine spray, packed for Sheridan Croxted Ltd. by the Pressure Aerosols Filling Co., Berkhamsted, will be supplied through the trade wherever possible and costs 12s. 6d. per 12 oz container plus postage and packing or £7 10s. 0d. per carton of one dozen, delivered free.

Circle **36** *for further details.*

Telcothene Powder (High Density)

THE Plastics Division of The Telegraph Construction & Maintenance Company now offers Telcothene powder for dip-coating made from Ziegler-type high density polythene.

Telcothene high density powder, while possessing the same chemical resistance and anti-corrosive properties as the "conventional" Telcothene powder, has several advantages deriving from the greater mechanical strength and rigidity of high density polythene though it also has certain limitations where the appearance of the coating is of prime importance. Its physical properties, including the higher density itself, are bound up with its chemical structure, the molecular chains being linear rather than branched, and therefore more closely packed together.

The softening point of high density Telcothene is about 20°C higher than that of "conventional" Telcothene, and coatings may be kept in contact with boiling water for short periods, though the long-term working temperature should not exceed 80°C. Alternating contact with hot and cold water over a long period should be avoided.

Comparative Properties of Conventional and H.D. Polythene

	Conventional	*H.D.*
Crystalline melting point (°C)	106·5-109·5	125-130
Density (g/cc)	0·92	0·94
Melt flow index	20	1·2
Thermal conductivity (cal/sec/cm²/cm/°C)	0·0007	0·0010
Specific heat (solid) (20-40°C) (cal/g)	0·55	0·47
Specific heat (liquid) (120-140°C) (cal/g)	0·70	0·9
Linear thermal expansion coefficient (cm/cm/°C)	0·00013	0·00020
•Ultimate tensile strength (p.s.i.)	1,500	3,000
•Elongation at break (%)	450	625
Hardness (Shore D)	45-55	63-74
Power factor	$2{\cdot}5 \times 10^{-4}$	$1{\cdot}0 \times 10^{-3}$
Dielectric constant	2·28	2·20
Dielectric strength (V/mil)	1,000	1,000
Volume resistivity (ohm. cm)	$>3 \times 10^{16}$	10^{16}
Water vapour permeability (g/sq.m./24 hrs. at 38°C. 90%r.h.)	16	7·2

•—Rate of extension 4 in. per min.

Circle **37** *for further details.*

Peak Accelerometer Measures Shock Inside Packages

To meet the growing demand for a high quality and relatively inexpensive electronic instrument capable of measuring shock inside packages and the cushioning properties of packaging materials, Ferranti Limited have now introduced a portable peak accelerometer. It can also be used for measuring peak G values in vibration testing.

The instrument comprises two main units, a probe for fitting on the sample under test and an indicator unit. The latter incorporates a cathode follower, an a.c. amplifier, a low-pass filter with a cut-off frequency of 675 c/s, and an output socket for connecting a cathode-ray oscilloscope. It is also fitted with a double-scale, 3½ in. dial rectangular flush mounted indicator, with mirror scale and knife-edge pointer, giving four ranges of G units from 0-25, 0-100, 0-250 and 0-1,000 G.

Circle 53 for further information

. . . *Yes!* YOU'RE YEARS AHEAD *with* SPEEDOMAX "H"

The compact instrument (11" x 12") at low cost

THIS line of indicators, recorders and controllers is unique—there is no comparable instrument available to you today. It is compact, all elements being readily accessible and all major components plug-in, and all moving parts operate by means of a common shaft driven by the positive worm gear of a high speed balancing motor. Limit of error is ±0·3% and balancing time 1 to 5 seconds.

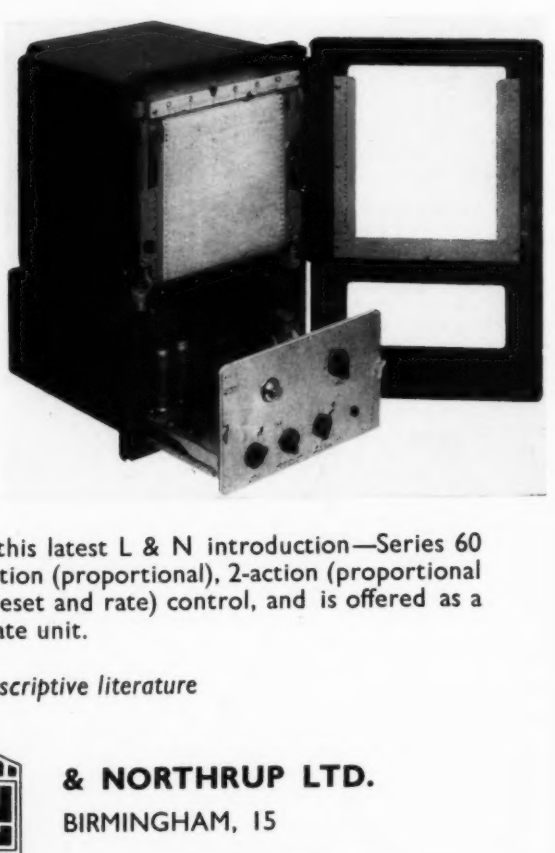
It is lower in cost than any comparable electronic potentiometer available today.

Speedomax "H" with Series 60 Control

Here is a completely new model of the Speedomax Type H potentiometer with additional controls now an integral part of the main instrument.

It is very compact, saving much panel space, being only $17\frac{5}{8}$" × 11" × 11".

The Control pulls out like a drawer.



Entirely new, and quite outstanding is this latest L & N introduction—Series 60 Electronic Control. It provides single-action (proportional), 2-action (proportional and reset) and 3-action (proportional, reset and rate) control, and is offered as a separate unit.

Send now for descriptive literature

INTEGRA, LEEDS
183, BROAD STREET,
Telephone : MIDLAND 1453/4

& NORTHRUP LTD.
BIRMINGHAM, 15
Telegrams : FLOMETER, BIRMINGHAM

British made in Birmingham

Minimum readable G is 3. Manipulation of a switch on the instrument enables vibration readings from 8 c/s to 750 c/s to be obtained.

A special negative feedback technique used within the electrical system ensures that both short and long term reading repeatability is of a high order.

The acceleration-sensitive element or probe consists of a barium titanate crystal accelerometer fitted in a metal housing with an output lead of screened cable, nominally 12 ft long, for plugging into the indicator unit. By supplying a nominal 12 ft length of cable, the manufacturers ensure that all probes including cable have the same acceleration/voltage sensitivity. A sensitivity of 9 mV/G is obtained at the probe socket on the front panel. The instrument, which is electronically calibrated, can also be supplied with a 60 ft length of special low-capacity coaxial cable if required.

The probe can either be attached directly to a rigid member of the sample under test or to the inner cargo container (for package testing).

Overall dimensions of the indicator unit are: length approximately 13 in., height 10¼ in., width 6½ in. Weight is 15¾ lb approximately. Weight of probe and 12 ft of cable is about 5 oz.

The instrument operates from the normal mains supplies, i.e., 230-250 volts, 50 c/s, but when required, it can also be supplied suitable for 105-120 volts, 50-70 c/s.

The basic price of the Ferranti peak accelerometer, supplied with 12 ft of coaxial cable, is £212.

Circle **38** *for further details.*

B.T.L. "Bara" Wide Range Incubator

THE B.T.L. "Bara" wide range incubator, of all-metal construction, is of the water-jacketed type and is capable of direct operation at temperatures up to 80°C. It can also be operated at temperatures below ambient by passing external cooling water through the jacket.

Typical temperature variations at one point in the chamber are ±0·4°C at 37°C and ±0·2°C at 56°C, while the maximum temperature differential between two points in the chamber is 1·5°C at 37°C and 3·0°C at 56°C. Temperature control is effected by a B.T.L. bimetallic regulator operating through a Sunvic relay, reproducibility at a fixed setting being ±0·5°C. Accurate temperature setting is achieved by means of a control knob with an arbitrary illuminated scale of 0-100 having an effective length of 10 in., used in conjunction with a separate calibration table supplied with each incubator.

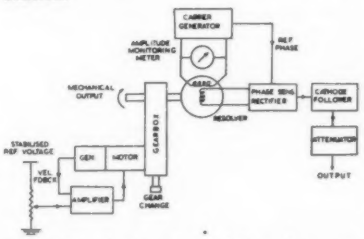
The control panel, which carries mains and heater pilot lights and the illuminated regulator scale, is recessed into the sheet metal case of the incubator beside the door, and has a removable "Perspex" cover to protect it from casual interference. Above the control panel is a recessed illuminated thermometer reading 0-100°C in 0·5°C, which allows a check to be kept on the chamber temperature. The tinned copper chamber, 20¼ in. wide × 17 in. deep × 27 in. high, is fitted with runners so that the three shelves provided with each incubator can be used in any three of six possible positions. An inner door of ¼ in. toughened plate glass with a magnetic latch protects the chamber. The chamber jacket allows the circulation of water around the top, bottom, sides and back of the chamber, giving extremely even heating, and the inlet and outlet water tubes are of carefully proportioned sizes to eliminate overflowing. The top of the incubator is fitted with a water level indicator, a breather tube for the jacket, and a tubular pocket which allows a second thermometer, thermocouple or other device, such as a stirrer, to be inserted into the chamber.

The incubator weighs 216 lb empty and 316 lb when operational, the capacity of the jacket being about 10 gallons. The incubator is fitted with a 6 ft lead with open ends and can be supplied for operation on 100/115 V or 200/250 V, a.c. only, with a mean consumption of 100 watts at 37°C and 160 watts at 56°C.

Circle **39** *for further details.*

Low Frequency Generator Type 110 and 111

THIS new generator has been designed to provide a precision test instrument required in development and testing of control systems and automatic machines. It combines simplicity of construction and robustness with good stability of waveform and amplitude and frequency calibration.



Principle of operation of low frequency generator

The main part of the generator consists of a resolver rotating with carefully stabilised angular speed. Such resolver can be considered as a variable ratio transformer, where the turns ratio is proportional to the sine of the angle between the stationary winding and the resolving rotor at any instant. The stator is supplied with a constant amplitude carrier signal. The output from the rotor will be proportional to the supply voltage multiplied by the turns ratio.

This signal is rectified by means of a phase sensitive rectifier which removes the carrier component of the signal. The signal is then applied to an attenuator and a cathode follower to produce an output signal with a low source impedance.

The resolver is driven through a two-speed gearbox by means of a servo motor-generator and a high gain servo amplifier. The output of the generator is applied as a velocity feedback to the input of the amplifier, where it is compared with a velocity input signal derived from an electronically stabilised supply by means of a chain of high stability precision resistors. The high gain of the amplifier ensures that the motor runs substantially at the speed corresponding to the voltage selected. The amplitude of the output signal does not depend in any way on the generated signal frequency as it is a function of only the input carrier voltage and the turns ratio of the transformer. The carrier is derived from a stabilised oscillator and is further monitored by means of a meter on the front panel of the instrument.

It is possible to stop the generator at any point within the output waveform cycle. The generator will start from any pre-set position without introducing any transient. The starting and stopping is almost instantaneous as the servo motor is capable of very fast acceleration and braking.

The mechanical output of the generator is available in the form of a rotation of a shaft revolving with a speed of 1 rev/cycle. It can be therefore used as a precision variable speed drive for experimental laboratory use.

The instrument can be used to supply slowly varying sinusoidal signals for testing of all kinds of process controllers and servomechanisms

It can be used to produce a modulated a.c. signal within the carrier range covering most of the existing a.c. operated systems, i.e., 50 c/s-3 kc/s.

The instrument can be used to drive a large variety of experimental devices with the speed adjustable by the controls on the front panel. Variable loading, provided it falls within the torque range covered by the instrument, will have only very slight effect on the output speed which is servo controlled. The instrument can be used to drive switch assemblies in automatic machines in order to determine the speed range within which these machines work correctly.

The low frequency generator when fitted with a pen recorder can provide a very useful tool for the investigation of harmonic response of control systems, industrial plants and servomechanisms.

Circle **40** *for further details.*

Decimal Indicator Tube

A COLD cathode decimal indicator tube (Type Z503M) has been introduced for use in the high-speed stages of counting equipments.

In slower-speed counting stages, decimal stepping tubes, which give a visual indication of the count, are used. But for high-speed counting conventional hard valves, or specialised tubes like the trochotron, are necessary, and these require some external indicating device.

Various types of indicator are available, but the Z503M has the advantage of displaying the count in the same way as a decimal stepping tube, and thus enables the visual presentation to be made uniform throughout all stages of the counting equipment.

The Z503M consists of an anode and ten cathodes, with each cathode brought out to a separate pin so that ten connections can be made to the counting circuit. The count is indicated by a glow discharge on the appropriate cathode. The tube gives 'end-on" viewing of the discharge, the position of which can be identified by an external numbered escutcheon.

The recommended anode current for the tube is 60 microamps; the minimum anode-to-cathode voltage necessary for ignition is 129 V (with some ambient light); and the voltage across the tube and

a 500 kilohm series resistor below which the glow will extinguish is 105 V.

The Z503M is mounted on a duodecal (B12A) base, and has a maximum seated height of 70 mm and a maximum diameter of 33 mm.

Circle **41** *for further details.*

Mains Failure Alarm Bell

A SIMPLE mains failure alarm not requiring batteries or auxiliary supply has been developed.

The equipment consists of a clockwork bell which will ring as soon as the mains supply to the coil of the relay chassis is broken.

The bell will ring for two minutes and is rewound simply by turning the bell dome in a clockwise direction.

The bell can be fitted with a visual device to indicate that it needs rewinding. An auxiliary relay Type SMF can be supplied to give an alarm or indication where a battery supply is available.

To provide a visual indication of a healthy supply a miniature mains neon lamp can be supplied with the unit as an optional extra.

Circle **42** *for further details.*

10 W Zener Voltage Regulators, and Zener Voltage Reference Diodes

TEXAS INSTRUMENTS LIMITED announce a new range of silicon Zener voltage regulators, Types 1S501-1S516 as well as new silicon Zener voltage reference diodes.

The 1S501-1S516 series of silicon Zener voltage regulators is stud-mounted and covers the voltage range of 22 to 91 volts in 16 steps. These new regulators are rated at 8 watts dissipation, are available with Zener voltage tolerances of 5% or 10%, and can be supplied with anode to stud, cathode to stud, or as double anode clippers.

The 1S207-1S218 series of Zener voltage reference diodes covers the range 3·6 to 10 volts in 12 steps. They are available with Zener voltage tolerances of 5% or 10% and are hermetically sealed in small molybdenum-glass sleeves.

These semiconductor devices are available in prototype quantities now and large scale production is now commencing.

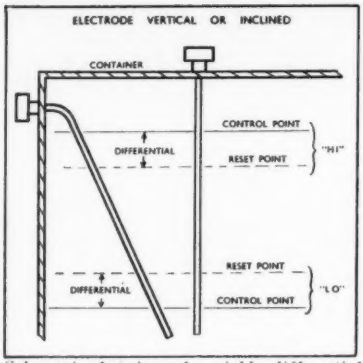
Circle **43** *for further details.*

Viton Diaphragm Improves Flow Metering

HONEYWELL CONTROLS LIMITED have recently raised flow and liquid level metering accuracies by installing a new high-performance diaphragm on their differential converter transmitters.

The "pneumatic balance" differential converter, which previously contained a Fluon-coated diaphragm separating high and low pressure chambers, now uses Viton as a diaphragm coating. Honeywell's production engineers have found that the new diaphragm provides better long-term stability of measurement and higher stability under varying temperatures. The chemical resistance of the new diaphragm is good, and it can be used to meter alkalies, amines, hydrocarbons, and dilute or concentrated mineral acids. The Teflon-coated diaphragm remains available as an option for metering substances which might attack the new diaphragm.

Circle **44** *for further details.*



Schematic drawing of variable differential control, 1-40 pF

"Leveltron"

THE "Leveltron" is a capacitance-operated switch with continuously variable differential control which can be used for measurement at up to 60 yards from the point of detection. The measuring unit is located in the main control box, not in the electrode, thus ensuring accessibility and no exposure to injurious atmosphere or vibration. Each model is available with remote control facilities including from 6-60 yards of coaxial cable. The "Leveltron" has a variable differential control from 1-40 pF, which can be selected by the adjustment of two controls. The first sets the control point of the relay and the second varies the reset point without affecting the setting of the control point and so fixes the differential as required.

The instrument is applicable for the majority of industrial applications for free flowing solids and liquids from flour and wood shavings to coal and limestone. It may also be used for monitoring sight glass or manometer levels.

The control point drift is less than ± 1 pF and the differential drift is less than $\pm 0{\cdot}5$ pF over a period of three months given steady supply voltage and temperature. Variations from humidity are negligible.

The instrument varies in price from £26 to £46.

Circle **45** *for further details.*

Holiday Detectors

SPECIALLY developed for the inspection of pipeline coatings, the Ionic Holiday detectors have a wide field of useful applications where it is essential to be sure of a perfect paint or coating on tanks, boat hulls, vessels, pilings, bridges, gas holders or any metal structure, or for "flash" testing of insulation of various components.

A portable instrument,utilising a high tension coil and specially designed interrupter enables an output of 30,000 kV to be obtained from a 6 volt accumulator.

The design is such that the instrument can be handled with complete safety, a "twist" safety switch is fitted in the lid, a red warning light showing when the instrument is in use. Should the operator open the lid, the unit is automatically switched off.

In use, with the output voltage obtainable from the high tension coil, the sound of the spark jumping can easily be heard and seen at any point of the Holiday.

Circle **46** *for further details.*

Manufacturers' Publications

Micron Filter Unit

This filter has been developed to meet the need for highly efficient microparticle filtration of fluids for precision hydraulic components. Two models are described, one for direct line filtration and the other for integral mounting with an electro-hydraulic servo valve.

Circle **47** *for further details.*

I.R. Gas Analysers

The principle of operation and a description of the instruments are given together with a price schedule.

Circle **48** *for further details.*

Holding and Lifting Permanent Magnets

A range of power, button and pot type permanent magnets suitable for holding, lifting and positioning purposes is illustrated in this leaflet together with dimensional details for standard sizes available and their approximate weight lifting capacity.

Circle **49** *for further details.*

Seetru Gauges

Liquid level instruments of gauge glass pattern are described in a series of leaflets.

Circle **50** *for further details.*

Electro-hydraulic Servo Valve

The function of this instrument is to meter hydraulic fluid under pressure in direct proportion to the value of an electrical signal. Details are given in this brochure of the principle of operation, valve sizes, electrical input, hysteresis and response.

Circle **51** *for further details.*

Conductivity Cells

New conductivity measuring cell developments are described. The CCB/E cell is a recent development of the high pressure type CCB cell. It has been produced for installation in steam condensate hot wells where rising and falling levels would cause the standard pattern of cell to be flooded.

Circle **52** *for further details.*

Imlok Manual

No. 159 of this manual gives details of the basic elements and detailed drawings of Imlok structures and accessories.

Circle **53** *for further details.*

Instrument Catalogue

The seven sections of this catalogue give data on: counting equipment; nucleonic apparatus; general purpose instruments; process control apparatus; data conversion equipment; electrical weighing and weighing control equipment; and miscellaneous equipment (cases, cabinets, connectors, etc.).

Circle **54** *for further details.*

Servo Valve Drive Amplifier

This amplifier provides the link between the signalling elements of a servo loop,

e.g., inductive pick-offs, synchros, etc., and the electro-hydraulic servo valve.
Circle **55** *for further details.*

Instrument Cases

The brochure illustrates the standard range of instrument cases, together with the current price list.
Circle **56** *for further details.*

Bulgin Bulletin

New developments in instruments and components are described briefly.
Circle **57** *for further details.*

Hellerman News Sheet

This first issue includes brief details of a pneumatic sleeve-fitting tool, "Suprafix" spring-loaded terminal blocks, and a wire stripper.
Circle **58** *for further details.*

Mini-line Pneumatic Control System

This booklet compares existing systems with the Mini-line transmission systems and the range of Mini-line equipment is described and illustrated.
Circle **59** *for further details.*

Photomultipliers

Details are given of photomultiplier tubes for scintillation counting. A table lists the characteristics, dimensions and electrode connections for the range of tubes.
Circle **60** *for further details.*

Assembly and Storage Trays

The leaflet gives particulars and prices of additions to the range of Kabi bench assembly trays and storage bins.
Circle **61** *for further details.*

CP Instruments

Data are given on 240° circular scale moving-coil ammeters and voltmeters, and panel mounting moving-coil instruments.
Circle **62** *for further details.*

Relays

A series of pamphlets gives details of a range of miniature relays, glass sealed relays, and polarised relays.
Circle **63** *for further details.*

Bailey Meters' Sales Literature

The latest additions to the sales literature give details of the following products: area meter transmitter; electronic recorder; edgewise self-balancing indicator; solids flow failure alarm; transistorised trip margin indicator; transistorised on/off controller and alarm; electronic self-balancing strip chart recorder; transistorised on/off controller; automatic voltage regulator.
Circle **64** *for further details.*

Process Response Analyser

This is a precision electronic instrument capable of measuring system transfer functions in the frequency range 1 cycle in 10,000 seconds to 100 c/s. The leaflet gives details of the applications of the instrument and a technical description of it and its components.
Circle **65** *for further details.*

Pressure Transducer

The Type NT.4-317 pressure transducer is capable of continuous operation at 600°F while gauge pressures between 100 and 5,000 p.s.i. are being measured. A special adapter can be supplied to extend the operating range to 2,000°F.
Circle **66** *for further details.*

Analogue Computer Techniques

This booklet contains a general description of analogue computer techniques and existing applications and also gives a more detailed account of the uses of the Solartron "Minispace" computer.
Circle **67** *for further details.*

Digital Voltmeters

A new range of digital voltmeters for use as direct measuring instruments and also for incorporation as readout and programming aids in equipment are described in this two-page leaflet.
Circle **68** *for further details.*

Your Control Problem

This is the title of a small booklet which lists the firm's range of standard components from which a control system can be built up.
Circle **69** *for further details.*

ERA Electronic Reading Automation

ERA has been designed to recognise printed characters and to convert this information for use by standard punched-card or computer installations. This 15-page publication describes the first production machines for reading printed characters from continuous rolls of paper and applications of this type of machine together with operating details.
A general review is also given of other types of machine under development.
Circle **70** *for further details.*

Minispace Analogue Computer

The applications and operation of this computer are described briefly.
Circle **71** *for further details.*

Introview

Introview is a flaw and corrosion detector which operates on an eddy current principle. The 13-page booklet gives details of the instrument, its operation and applications.
Circle **72** *for further details.*

Datatape

Datatape is a precision magnetic tape recorder-reproducer system.
The leaflet lists instrument and environment specifications and gives graphs of signal-to-noise ratios over various frequency ranges, reproduce-head responses at the six tape speeds and peak-to-peak flutter at each of the six tape speeds.
Circle **73** *for further details.*

Precision Electronic Instruments

The instruments briefly described include: amplifiers; ignition delay meter; attenuators; pulse generators; millivoltmeters; oscillators and Digicators.
Circle **74** *for further details.*

Kelvin House: Kelvin and Hughes' new head office

Opening of Kelvin House

Kelvin House, Wembley, was officially opened on 4th May by Sir David Eccles, President of the Board of Trade. Mr. G. B. G. Potter, managing director, Kelvin & Hughes Ltd., and Smiths Aviation and Marine Divisions, welcoming Sir David, gave the reasons for the building of Kelvin House:

"It can be asked why we have located this building in a London suburb and not in central London. The reason is that we felt conditions in the centre of London are likely to become ever more congested. It seemed, therefore, looking ahead, that our wisest plan was to concentrate all of our central London staff at a suburban centre well served by public transport. I believe we are amongst the first firms in London to have done this.

"The interests associated in Kelvin House comprised, a few years ago, six separate companies, all either ploughing their own furrow or, on occasion, actively in competition. Comparatively recently it was realised that their businesses were more complementary than competitive, and that they had plenty of competition from other sources, particularly overseas, and so had much to gain and little to lose by association. The net result is an association of firms which today is a world force in the instrument industry instead of six separate entities which singly had not the strength necessary for survival."

The building, which cost approximately £250,000, fronts Wembley Park Drive and adjoins the Olympic Way entrance to the Wembley stadium. It has been called Kelvin House in memory of Lord Kelvin, who was a founder of one of the original companies of Kelvin and Hughes.

Designed in contemporary style, the building presents a curved glazed facade of seven storeys, rising to a height of 85 ft and encloses a floor space of nearly 50,000 square feet of office accommodation.

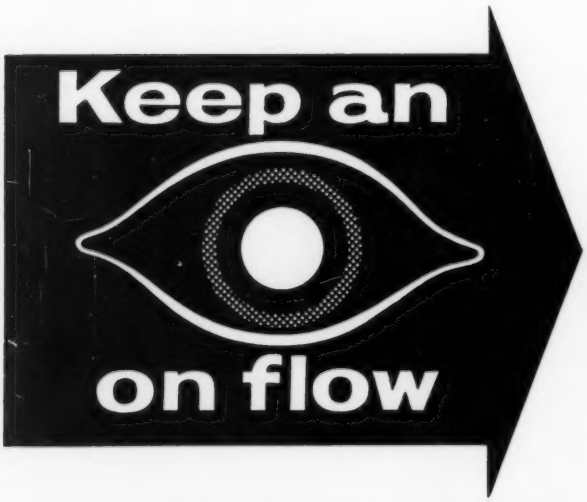
Principal features of the building include tower staircase windows running the full height of the east elevation with relieving panels of blue vitreous enamel. The entrance hall is pavonazzo marble paved and is flanked by a mosaic colonnade.

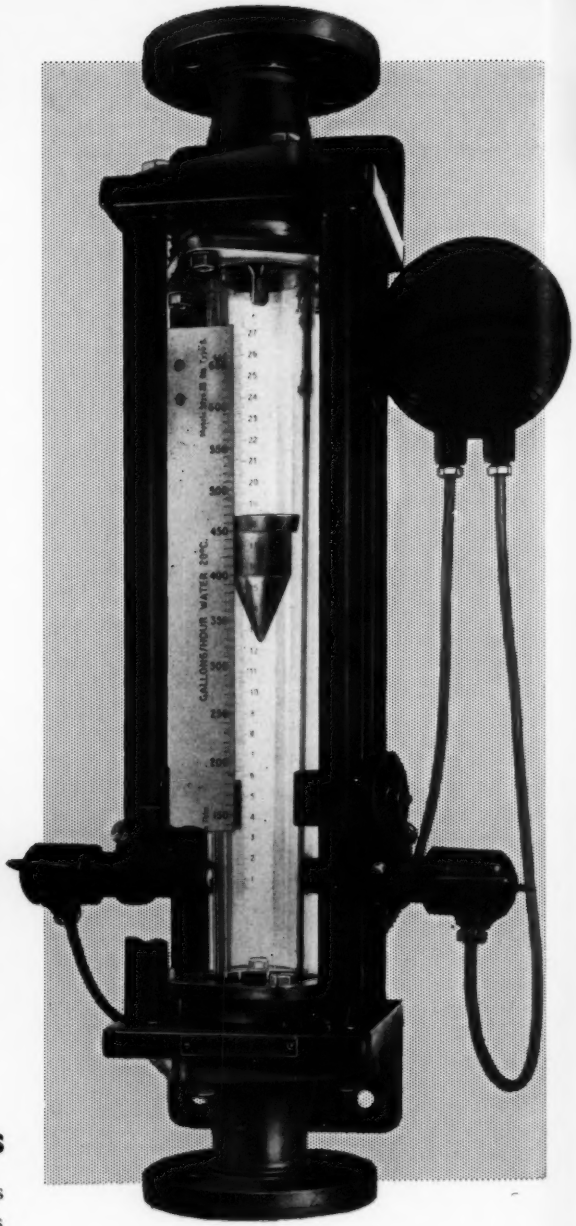
Circle 54 for further information

A photo-electric alarm is now available for fitting to Rotameter Flowmeters types 907 and 914. This unit is made in one size only which can be fitted to any size of instrument.

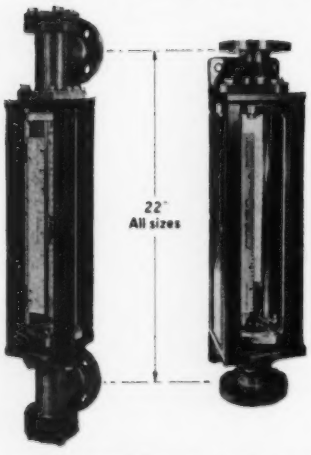
Note these advantages:

- ★ Positive action to operate audible or visual alarms, etc.
- ★ Simple and reliable; easily installed
- ★ Will signal high or low degrees of flow rate
- ★ 2 alarms can be used to provide high and low flow alarm
- ★ One size of alarm fits any size of type 907 or 914 frame
- ★ Can be fitted to instruments already installed





METRIC SERIES 'B' FLOWMETERS



The Metric series Rotameters employ standardised tubes and floats with three types of float (for different fluids) for each of eight sizes of tube. Tubes, floats and gland packing (including P.T.F.E.) of a given size are fully interchangeable.

Range: 0.1 to 200 L/min. Water at 20°C.
1 to 2,000 L/min. Air at N.T.P.

Write for technical details quoting reference IP/MA

ROTAMETER
FLUID MEASUREMENT AND CONTROL
FLOW-DENSITY-LEVEL

ROTAMETER MANUFACTURING CO. LTD., 330 PURLEY WAY, CROYDON. Tel: Croydon 3816.

MIS

NEWS OF THE INDUSTRY

Elliott-Automation Agreement with Canadian Curtiss-Wright Ltd.

ELLIOTT-AUTOMATION LTD. announces that its subsidiary, Elliott Brothers (London) Ltd., has secured from Canadian Curtiss-Wright Ltd., exclusive rights to make and sell the nucleonic thickness measuring apparatus developed by that company.

The equipment's detector system consists of an enclosed radioactive source of radiation and a sensing element which measures the absorption of the radiation by the material being gauged. The sensing element provides an output signal from which an accurate measurement of thickness is obtained, thus providing a means of controlling automatically manufacturing processes and making records of the weight of materials produced. In cases where it is applicable, a continuous measurement of moisture content can also be made and recorded.

The techniques employed have particular application in the paper, plastic, sheet metal and rubber industries and the "know how" and experience in the application of these devices is being made available to Elliott Brothers by Curtiss-Wright.

Mullard Factory to be Built in Lancashire

WORK will commence shortly on the construction of a new factory at Simonstone, Lancashire, for Mullard Ltd.

This factory will produce glass for the production of T.V. tubes by the company which is at present purchased as prefabricated parts. Mullard prefers, where possible, to start production right from the raw materials and glass for valves is already made within the company.

The new works are to be built on a 24-acre site adjacent to the existing Mullard tube factory at Simonstone and it is hoped that it will commence production later next year. The cost of the plant will run into seven figures and it will eventually provide employment for a considerable number of people.

The Mullard Company already has over 8,000 employees in Lancashire.

Coventry Gauge and Tool Brechin Factory

COVENTRY GAUGE AND TOOL CO. LTD. are to transfer work from their Midlands plant to their Brechin factory. This is part of a plan to improve employment in the Scottish area and already work has resumed on a five-day week after a period of four-day working. The company plans to expand the Brechin plant and will employ a further 200 workers there. The improvements follow the Budget situation and the generally improved tone in the machine tool field. The Coventry company has recently undertaken an Admiralty contract and efforts were made to secure that work for Scotland. The Government view is that it cannot direct a firm to locate work in any area but that the industry should itself have regard to the spreading of work on a sound basis and this is the policy now being adopted.

I.M.E.K.O.

THE proceedings of the International Measurement Conference which was held in Budapest in November, 1958, will be available during the autumn. The 145 papers which were presented will be published in the language of presentation.

New Company

UNITING in one company, the combined technical knowledge,resources and specialised manufactures of the Drayton Regulator and Instrument Company of England and the Johnson Corporation of America, Drayton Johnson Limited has been formed to make available to paper, plastic, rubber, textile and other machinery manufacturers and users, a complete steam engineering service.

New Installation in Firth Cleveland Fuel Flow Test House

FURTHER equipment has been added to the Firth Cleveland Fuel Flow Test House, which was opened in June, 1958, by the Minister of Supply at the works of Simmonds Aerocessories Ltd., at Treforest (see *Instrument Practice*, Aug., 1958, p. 887). The installation, which comprises a De Laval 100 cc "Precision" test tube centrifuge with ancillary equipment, is one of the largest of its kind in this country and Europe.

Baldwin Instrument Co. New Agents and Technical Representatives

SCOTLAND	
Sales and Service and Technical Representation. Tel.: Shettleston 4206-9	James Scott & Co. Ltd., 68 Brockville Street, Carntyne Industrial Estate, Glasgow, E.2.
NORTH OF ENGLAND	
Sales and Service. Tel.: Leeds 33781-2	Wm. Don & Partners Ltd., Crown Works, Crown Point Bridge, Leeds, 9.
Technical Representative. Tel.: Horwich 364	Mr. J. D. Thornley, Waterhey Cottage, Rivington, Nr. Bolton, Lancs.
MIDLANDS	
Technical Representative. Tel.: Kings Norton 4476	Mr. P. Lawrence, 16 Hawthorn Road, Kings Norton, Birmingham, 30.

CTA's for Ketay Synchros

KETAY LIMITED announces that Ministry of Supply Certificates of Technical Approval have been received for Ketay Synchros Types 15CT4a, 15TR4a, 15CDX4a and 15CX4a.

Ketay Limited was recently granted Design Approval under the Ministry of Supply Instrument and Electrical Equipment Design Approval Scheme.

Mobile-Exhibition Tour in U.K.

THE KENT MOBILE-EXHIBITION, now embarked on a nine-week United Kingdom programme covering a route of over 1,600 miles, is scheduled to stop at approximately 30 different locations. It will be available for inspection by engineers and industrialists between Cardiff, Glasgow and Scunthorpe, and features a selection from the wide range of Kent industrial instruments and controls.

This travelling showroom, in the last months of 1958, aroused a great deal of foreign interest during an extensive overseas tour which included the Scandinavian countries, Belgium, and East and West Germany.

The comprehensive range of equipment on view includes the latest Kent electronic developments, such as the Mark 3 Multelec electronic strip-chart indicator/recorder (recently released for general industrial use); the Commander KE electronic circular-chart indicator/recorder/controller; and a selection of Kent electronic component assemblies. One of these—the highly-sensitive synchronous converter—is demonstrated by means of a stroboscopic display unit.

High-Fidelity Amplifier to Test Missiles

THE industrial electronics department of Westinghouse Electric Corporation claim to have built the world's largest and most powerful high-fidelity amplifier. The amplifier will be used to test Polaris missile parts.

The amplifier has an output capacity of 200,000 watts, about 20,000 times more powerful than most high-fidelity radiophonographs, and will be used by Lockheed Aircraft Corporation at its Sunnyvale, California, plant to test components and sub-assemblies of the Navy's Polaris missile.

Instead of being connected to a conventional speaker system, the amplifier will cause a platform to vibrate. This platform is three feet in diameter and is arranged so that missile parts can be attached. It vibrates at pre-determined frequencies for the same reason that the cone in a loudspeaker vibrates to produce sound.

The amplifier is valued at over $100,000 and is twice as powerful as any similar amplifying system produced in the past. It is 24 feet long, seven feet high and three feet wide. It weighs about 10 tons and at full power will need as much electricity as several hundred average homes.

With this amplifier, it will be possible to test missile components to destruction if necessary in order to establish how much vibration the parts can withstand. It would be possible to "play" the tape recordings of vibration from a recovered missile through the amplifier to test components on the ground under conditions that duplicate those in flight.

E.M.I. Speakers at Ergonomics Conference

A LARGE attendance gathered at Oxford, from 6th to 9th April, at the Ergonomics Research Society's 10th Anniversary Conference, to study "the relation between man and the environment in which he works". The Conference was opened by the Rt. Hon. Ernest Marples, M.P., Postmaster-General.

Up to now, ergonomics has been largely the plaything of "backroom boys" at universities and research institutions. Only three industrial organisations in this country have trained ergonomists on their staffs. One of these companies, E.M.I. Electronics Ltd., provided two of the three speakers from industry at this year's Conference. Mr. B. Shackel, M.A., A.B.Ps.S., read a paper on "Ergonomics and Electronics" and Mr. J. R. Arrowsmith, B.Sc.(Eng.), took as his subject, "Human Aspects of Numerical Control".

E.M.I. Electronics first became interested in the application of ergonomics to industry about five years ago. In view of the company's many Ministry projects and the expansion of its commercial activities, it was felt desirable to make major studies of the various items of E.M.I. equipment, with a view to making them more readily usable under the exacting conditions prevailing in industry.

Mr. Shackel—who spent several years with a research unit at Cambridge before joining E.M.I.—says, "an ergonomist must expect to take about two years to settle in industry, to learn to establish rapport quickly with engineers. He can soon become useful in improving the detailed design of knobs and dials, but should aim to be called in early enough to contribute to the design of panel and system layouts".

An example of the application of ergonomics at E.M.I. is a new range of oscilloscopes. As new products are developed, the ergonomist will be encouraged to play his full part, not only by advising on operator aspects of system design, but by acting as a "catalyst" to enable engineers to clarify and crystallise their own ideas as they explain them to someone with a totally different outlook.

Second Presentation of Arthur Hughes Prize

MR. HUGHES presented the Arthur Hughes prize for the second year to the apprentice who had showed in his final year the best ability as a craftsman at the Kelvin Hughes factory at Barkingside recently.

Instam television audience measuring equipment

This year among more than 200 applications for apprenticeship—a record number—were 23 from boys whose parents are employed already by Kelvin Hughes. Applications were received from all parts of London and not, as formerly, from the local area. This appeared to indicate an increasing awareness among boys and parents of the value of sound basic training.

Seven other apprentices received awards from Kelvin Hughes after being judged as reaching particularly high standards during the past year. They were: Howard Stanley Crouch (Walthamstow), Ramon Henry Meehan (Hainault), Colin J. Goodey (Hainault), John W. Snell (Barkingside), David Brian Chizlett (Chadwell Heath, Romford), Allen Russell Jackson (Hainault), Geoffrey Stanley Frost (Barkingside).

Price Reduction on Royston Instruments

ROYSTON INSTRUMENTS LIMITED announce that because of increased sales and streamlining of production on a batch basis they are able to reduce by 15% to 20% the price of their equipment including all components of the Midas range of recording apparatus.

Electronic Measurement of Television Audiences

A BRITISH electronic development that shows instantaneously the size of television audiences, and whether viewers are switching channels or turning off, is now installed and operating in London. Known as Instam, this new system of measuring television audiences has been developed in this country by Television Audience Measurement Limited (TAM).

The Instam system of audience measurement involves electronically linking a statistical sample of homes capable of viewing ITV to a central control room by means of land lines provided by the G.P.O. At present there are 15 homes linked to each main land line and as there is no limit to the number of land lines that can be fed into the central control room, the statistical sample from which the data is deduced can be built up to any required figure.

As information from sample homes is relayed continuously over the land lines it is fed into a control console measuring 12 feet by 8 feet 9 inches, which presents it in visual form. This consists of indicators showing the current total of homes viewing ITV and BBC programmes, and illuminated graphs showing the percentage of homes watching ITV and BBC programmes. Percentages for one, two, three, four and five minutes ago are also shown. As TV sets showing ITV and BBC programmes are also incorporated in the console, an instant evaluation of programme preferences can be made.

The statistical information is projected instantaneously on to the illuminated charts and at the same time a permanent record is registered electronically. The information obtained can be processed so that it will be available for distribution to clients within a matter of a few hours of the end of programme transmissions.

BICC Bournemouth Depot New Telephone Number

As from Wednesday, 8th April, 1959, the telephone number of British Insulated Callender's Cables Limited, Bournemouth Depot, has been altered to:—

Bournemouth 36223.

Pyrotenax Ltd.: Changes of Address

PYROTENAX LIMITED announce that as from Monday, 20th April, the address of their London office will be 54 Victoria Street (Tel. No. Victoria 3745/9). More office space is now available and includes a display room and two fully equipped demonstration rooms for instructional and refresher courses where the latest ideas and developments in the application of

Pyrotenax Mineral Insulated Cables are incorporated.

In order to keep pace with the growth of business in Yorkshire, they have transferred their Leeds office to larger premises at East Parade Chambers, 10-12 East Parade, Leeds, 1 (Tel. No. Leeds 27826), where full display and demonstration facilities are also available.

Silver Staff Mace

MR. HERBERT H. ZEAL and Mr. Raymond O. Zeal presented a silver staff mace to the Company of Scientific Instrument Makers at a dinner recently.

Londex Representatives

HAROLD HUBBARD LTD., 2 Aylsham Road, Norwich, Tel. No. 25941, have been appointed by Londex Ltd. as technical representatives for the counties of Norfolk and Suffolk.

Winston Electronics: £15,000 to £500,000 in Nine Years

IN his ninth annual review of Winston Electronics Ltd., Shepperton, Middlesex, Mr. F. W. Reynolds, the managing director, revealed that the total value of the company's manufactured equipment had exceeded £500,000 during the year ending 28th February, 1959. This can be compared with the £15,000 equipment value during the company's first year ending 28th February, 1951. The labour force has increased from one initial employee in 1950 to 200 today.

SIMA at the Dorchester

SCIENTIFIC INSTRUMENT MANUFACTURERS' ASSOCIATION OF GREAT BRITAIN recently met for their thirteenth annual dinner at the Dorchester Hotel. Prominent among important guests from every branch of British scientific instrumentation were top men of nucleonics and electronics described by Sir David Eccles, President of the Board of Trade, as Britain's glamour industry.

English Electric Sub-office at Middlesbrough

A NEW sub-office of The English Electric Company was opened on 1st April, 1959, at 14 Albert Road, Middlesbrough (Tel. Middlesbrough 44346/7). Mr. A. R. Johnson, B.Sc., A.M.I.Mech.E., A.M.I.E.E., A.M.I.Prod.E., is in charge and is responsible to the manager of the English Electric branch office at Newcastle-on-Tyne, Mr. W. D. M. Lywood, A.M.I.E.E.

Johnson Matthey—Association with Metalli Preziosi

JOHNSON, MATTHEY & CO. LIMITED have acquired an interest in the Italian precious metal refining and manufacturing company, Metalli Preziosi S.p.A., of Milan. This old-established company, which has a history of over one hundred years of association with precious metals, is by far the largest enterprise of its kind in Italy.

It has its head office in Milan and its principal refineries and production centre in the new industrial zone of Paderno Dugnano, near Milan. Sales offices with local service facilities are maintained in Rome, Bologna, Florence, Genoa, Padua, Turin, Valenza, Vicenza and Verona. Extensions now in hand at the Paderno Dugnano works will presently complete a comprehensive modern precious metal metallurgical and chemical production plant.

Johnson, Matthey & Co. Limited have already been working in close collaboration with Metalli Preziosi for a number of years, and some ten years ago they entered into arrangements with this company with regard to their general representation in Italy. The closer association now announced is thus a logical development of previous understandings which have proved mutually advantageous. It provides for technical as well as commercial integration and gives the Italian company access to the resources of the research organisation of the Johnson Matthey group.

South Wales Tour by Parliamentary Secretary to the Board of Trade

AMONG the factories visited by Mr. John Rodgers, M.P., Parliamentary Secretary to the Board of Trade, in his recent tour of South Wales, was Simmonds Aerocessories Ltd., a member of the Firth Cleveland Group.

Mr. Rodgers was shown the Firth Cleveland Fuel Flow Test House, which was opened by the Minister of Supply last summer and which has recently been equipped with a 10,000 G centrifuge. Mr. Rodgers also inspected the new extension building now in course of construction for Firth Cleveland Instruments Ltd., and showed great interest in the relationship between the new factory and developments in the existing factory.

British Invention Wins Gold Medal at International Exhibition

AN international jury has awarded the gold medal in the Engineering Section of the 8th International Inventors' Exhibition to Mr. I. M. Furnivall, managing director of I.G.E. (Automation Division) Ltd., for his Masterotor automation control unit. The Exhibition, which was held in Brussels from 13th to 22nd March, 1959, attracted entries from 20 different countries, including Germany, Russia and the U.S.A.

Quantities of Masterotors are already in use at Pressed Steel Co. Ltd., and Ford Motor Co. Ltd., both at home and overseas, for the control of automation on car body production.

I.G.E. Ltd. is a member of the Udal Group of Companies which is centred at Court Road, Birmingham, 12. The Group provides a complete service for the design and manufacture of automatic handling and control equipment in press shops and elsewhere.

The Griffin and George Group at Lisbon Trade Fair (May, 1959)

GRIFFIN AND GEORGE (SALES) LIMITED, the selling organisation of the Griffin and George Group of laboratory furnishers, exhibited a representative range of laboratory apparatus and equipment suitable for both industry and education and bearing especially on the Second Six Year Development Plan on which Portugal is about to embark.

The stand was in the charge of the Group's export sales manager, Mr. Oliver Gregory, supported by one of their technical representatives, Mr. G. H. Jenner, B.Sc., and by a staff specialist in gas chromatography, Mr. A. Carling, who demonstrated the Mk. IIb version of the company's vapour phase chromatographic (VPC) apparatus.

British Instrument Industry Honour at Stevenage

ON a Royal tour around Stevenage Town Centre and the English Electric works, H.M. the Queen visited Fleming Radio Developments. Her Majesty was received at his factory by the founder and managing director, Mr. A. W. Jones, who explained the firm's products.

Standards Engineers' Conference

LORD HALSBURY, president of the Institution of Production Engineers, opened this year's one-day conference of engineers and others concerned with the application of standards in industry. The conference was held on 4th June at the Connaught Rooms, London.

Theme of the morning session at the conference was the significance of standards in the national economy, their application in the individual company and the place and function in the company of the standards engineer.

The discussion was introduced by speakers from the management side of two different types of firm and was followed by a paper on the detailed operation of a company standards department.

At the afternoon session speakers from the I.P.E. and the B.S.I. reported on the significant trends of their work as it affects standards engineers. A progress report was submitted from the I.P.E./B.S.I. committee (which organises these annual conferences) on matters that had come before previous conferences.

Co-operation between the standards, design, and the purchasing departments in firms was discussed with particular reference to making British Standards more readily usable as purchasing specifications.

Public Test House

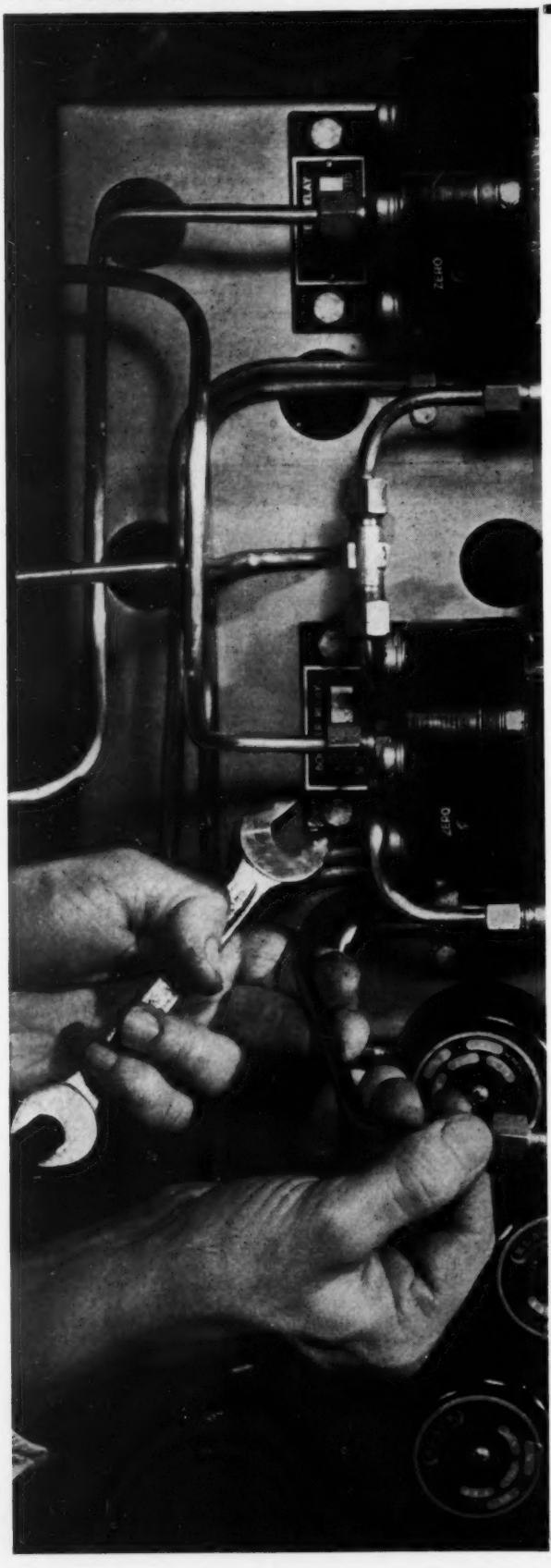
VICKERS-ARMSTRONGS (AIRCRAFT) LTD., South Marston Works, Swindon, Wiltshire, announce that their extensively equipped Public Test House is now available to industrial and scientific organisations, and operates under approval from the Ministry of Supply, Atomic Energy Research Establishment, Air Registration Board and Lloyd's Register of Shipping.

The comprehensive measuring equipment and instrumentation is certified by the National Physical Laboratory.

The scope of available services comprises metrology standards and gauge rooms, which are humidity and temperature controlled to international standards; electrical, electronic and instrument sections available for the standardisation, calibration and certification of instruments, and for all classes of repair, maintenance and experimental work.

In addition to these services, Vickers-Armstrongs Public Test House includes a fully equipped Materials Laboratory incorporating chemical and metallurgical facilities, and a Radiological Laboratory embracing X-ray apparatus, and equipment for gamma-ray radiography.

Circle 55 for further information



SUNVIC have a hand in most industrial processes

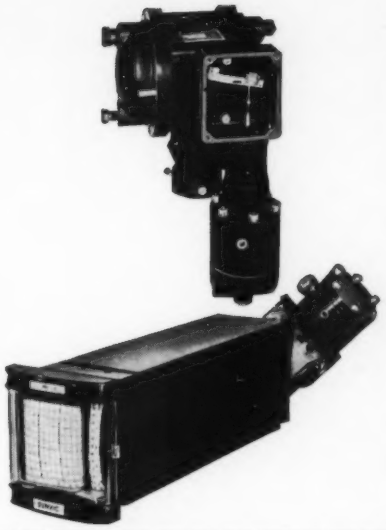
There are very few industries indeed in which there are not, somewhere, processes controlled by Sunvic instruments .... either pneumatic, electronic, electrical or electro-thermal. Sunvic activities range from graphic panels and integrated measurement/control systems to components for numerous industrial purposes, from complete reactor instrumentation to equipment for science and research.

This is part of a unit for scanning pneumatic signals in Sunvic automatic data handling equipment.

Pneumatics

Differential Pressure Transmitters: withstand full body rating overload in either direction; standard differential ranges 0-20 to 0-400 inches w.g. Safe working pressure up to 6,000 p.s.i. (forged steel). Ambient temperature limits −32°C to +94°C. Up to 800% zero suppression.

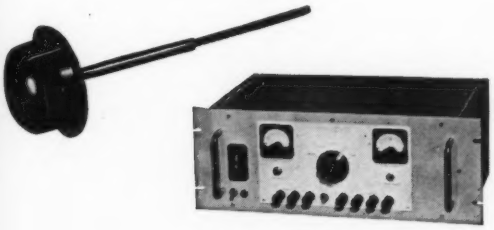
Recording Control Station: available as single or duplex recorder or as control station with auto/manual switching. Chassis completely removable without tools leaving process on control. Detachable, interchangeable chart drive. All zero adjustments from front.



Components and electronic instruments

Adjustable Bi-metal Thermostats can control temperatures up to 300°C. Stem lengths up to 22″; adjustment ranges up to 250°C. Normally closed or normally open contacts.

D.C. Amplifier: high stability and linearity make this ideal when measuring/recording thermocouple or straingauge output. Ranges: 0.1mV to 100mV; zero stability ±.001mV over 1,000 hours at 1mV range.



Complete systems

This is one unit from an automatic data handling installation monitoring over 2,000 points measuring temperature, voltage, current, etc. Besides automatically printing out a consolidated log sheet of all readings the equipment gives warning if any point exceeds pre-set maximum or minimum values.

Send for details

of Sunvic pneumatics, components or data processing to:

SUNVIC CONTROLS LTD
P.O. BOX 1, HARLOW, ESSEX
TEL: HARLOW 25271

SUNVIC

An A.E.I. Company

Instruments and complete instrumentation

150 kV Newton Victor X-ray unit with 360° beam tube in operation at Farrar Boilerworks Ltd.

X-ray Detection of Faults

FARRAR BOILERWORKS LTD. have recently put into operation a new X-ray unit for the radiographic inspection of welded joints on test pieces and specimens of all-welded steam boilers.

The new 150 kV Newton Victor X-ray unit with 360° beam tube is easily transportable; the complete unit comprises a tubehead, control and water cooler. The tubehead, which is supported on a gantry stand, consists of a high-voltage transformer, a filament transformer and X-ray tube housed in a cylindrical steel container insulated with sulphur hexafluoride.

Adequate protection for X-radiation is provided for personnel as the test area is screened off from the rest of the factory. Controls for the equipment are operated from behind a lead screen to protect the operator.

Radiographic inspection of test pieces and pressure vessels in production has subsequently led to the mastery of automatic welding by the high-lift boom welding machine which gives smooth, deep penetration welds with easy slag removal.

Savings have resulted in the use of the automatic machine and Farrar are able to complete jobs in much less time than formerly required for hand welding. The machine consists of a Fusarc automatic welding head and control panel on a 17 ft 6 in. long boom, which is fixed at one end to a motorised carriage, within a vertical framework. The height can be adjusted and the roller bed carrying the vessel to be welded can be controlled by means of push-buttons on the welding head control panel. Extending from the welding head, at the other end of the boom, is a lay trough in which the operator can lie when welding external or internal seams of vessels. The machine is capable of carrying, traversing, and rotating a 12 ton vessel, and is suitable for the internal welding of vessels from 2 ft 6 in. minimum diameter and the external welding of vessels from 12 inches to 9 ft diameter.

Analysis of Motion by Film

THE use of film to analyse motion was the theme of John Hadland & Co.'s two stands at the Industrial Photography and Television Exhibition, Royal Albert Hall, 20th-24th April.

Hadland's exhibited the famous Wollensak high-speed cameras, made in the U.S.A., which are capable of exposing up to 16,000 frames per second; the special time lapse units which are manufactured at the Hadland works at Chipperfield, Herts.; and the Spectro motion analysis 16 mm. cine projector.

In both high-speed and time-lapse photography accuracy of exposure is the most essential feature, and the range of equipment on the two Hadland stands fully demonstrated this important aspect of these types of cinephotography.

High-speed photography has proved its worth both in the U.S.A. and in this country for its use with faster-than-sound aircraft, and guided missiles. At the reverse end of the scale time-lapse photography allows the camera to be used, without relying on human power of observation and possible error of interpretation and recording, to observe any action or process of operation, over a long period of time and to record it on film for subsequent study, analysis and retention.

Extension to Mullard Research Laboratories

Two new laboratory blocks are being built on a site adjacent to the existing buildings of Mullard Research Laboratories at Salfords, Nr. Redhill, Surrey.

An extra 45,000 square feet of floor space will be provided by the new buildings, which will consist of a three and a four storey block. This will house the electronics, telecommunications, transistor applications and television laboratories which have been built up during recent years, parts of which have hitherto been operating in temporary buildings. It will also improve the facilities for the valve, semiconductor and materials research activities.

Mullard Industrial Sales Representation

MULLARD representation to industry has been extended to provide closer and more frequent contact with customers throughout the country.

There are now eight industrial representatives covering the United Kingdom, each being responsible, in his own area, for liaison with capital equipment manufacturers and other users of the industrial products marketed by the Semiconductor Division, the Component Division and the Government and Industrial Valve Division of the company.

The complete list of Mullard industrial representatives and their territories is as follows:—

District	*Representative*
1. Scotland and Tyneside	Mr. D. S. King
2. Lancashire and Yorkshire	Mr. E. M. Head
3. N.E. Midlands	Mr. A. Sloan
4. S. Midlands and S. Wales	Mr. H. A. Millen
5. Oxfordshire and Buckinghamshire	Mr. J. White
6. N. London and E. Anglia	Mr. M. P. L. King
7. Southern Counties and West Country	Mr. C. W. Andrews
8. South London and Kent	Mr. N. C. Nicholas

The appointment of Mr. David Stanley King to cover Scotland and the Tyneside is new. Mr. King was educated at Scarborough High School, and subsequently attended Hull University when he gained a London degree in physics and mathematics.

Expansion of B.T.L. Research and Development Division

THE Research and Development Division of Baird and Tatlock (London) Ltd. has recently been doubled in size to keep pace with the increasing demand both for "Analmatic" equipment for automation in analysis and for new and redesigned standard laboratory instruments and apparatus.

To deal with these two aspects of the work of the division two main sections have been formed: they will be known as:

Research and Development
("Analmatic" Instruments)
Research and Development
(General Instruments)

The division, consisting of these two sections, will continue to operate under the direction of Sir Bernard Keen, D.Sc., F.Inst.P., F.R.S.

Plessey Form German Company

THE formation of a German company to further Plessey interests in the European market is announced by Plessey International Limited.

Registered as Plessey Maschinen Elemente G.m.b.H., with a nominal capital of D.M.200,000, the new company will be responsible for the manufacture of many products in the light engineering field, particularly those relating to hydraulic equipment. Production will be at Neuss, near Düsseldorf.

Directors of the new company are Mr. B. G. W. Attwood, Mr. T. White Wilson, Mr. P. W. Faulkner, Mr. D. G. Booth and Mr. R. Sellies (Geschaftsführer).

Taylor Controls' Midlands Area Office

AT the beginning of May Taylor Controls Limited opened their Midlands area office at:

2239 Coventry Road,
Sheldon,
Birmingham, 26.
Telephone: Sheldon 5594.

Mr. E. S. Jerams has been appointed as Midlands area manager.

This new office has been inaugurated as a further stage in the scheme to give complete and extensive coverage of the country, which will, at the same time, provide a more streamlined service to customers in their own locality.

In addition to the above, Taylor Controls Limited already have a branch office at 30A London Road, Manchester, 1, and are represented in Bristol for the South West and South Wales areas and in Sutton Coldfield and Nottingham for the Midlands, and in Stirling, Middlesbrough and Cheshire for the Northern area.

E.M.I. Colour T.V. used at Anatomical Symposium

WHEN the Anatomical Society held a symposium recently at the Department of Anatomy's lecture theatre, University College, London, E.M.I. Electronics Ltd.'s new colour television equipment was used to give the capacity audience a close-up view on a 4 ft x 3 ft screen of experiments

being carried out under a microscope in a small laboratory several floors away.

The lecturer demonstrated how to prepare biological specimens for use in an electron microscope. As thin sections of tissue vary in colour, when viewed in reflected light, according to the thickness of the slice, colour was the most important factor to be conveyed to the screen. The E.M.I. colour T.V. camera was connected to the optical microscope under which the tissue was being cut.

This is believed to be the first time in this country that this technique has been televised in colour.

I.C.T. in South Africa

THE two South African subsidiaries of International Computers and Tabulators (I.C.T.) — namely Hollerith Machines (South Africa) (Proprietary) and Powers-Samas (Proprietary)—are now merging under the title of International Computers and Tabulators S.A. (Proprietary) with an Ordinary capital of £1¼m.

The board will be as follows:—Mr. H. Gallow (chairman), Mr. C. A. Cilliers (deputy chairman), Mr. B. P. A. Vallance (managing director), Mr. A. M. Richford (deputy managing director), Dr. J. E. Holloway, Mr. H. G. Lederman, Mr. A. G. Norris, and Mr. W. D. Wheeler.

C. S. Lindsey: New Address

THE new premises of C. S. Lindsey Ltd. are now at:

Crown Works, Godman Road,
Peckham, London, S.E.15.
Telephone: New Cross 4636.

D.C.L. Magnetic Oxygen Analyser

THE DISTILLERS COMPANY LIMITED has granted to Servomex Controls Limited a licence to manufacture the 'null balance' magnetic oxygen analyser which is the subject of D.C.L. patents.

This instrument, which instantaneously measures the oxygen content of gas streams by means of the paramagnetic effect, has been developed for industrial process control and is already installed in a number of chemical plants. Its design is of interest for the manner in which the necessary robustness, shock resistance and general stability have been obtained without reducing the accuracy and fast response needed for effective control.

Sales and service for the analyser will be handled by a newly-formed department of Servomex Controls Limited, at Crowborough, Sussex (telephone: Crowborough 3566), to whom enquiries should in future be addressed.

Changes in Rigidex Sales and Service

British Resin Products Limited announce that Mr. G. E. H. Smock has been appointed sales manager for Rigidex Polyethylene. Also Mr. R. Hayes has been appointed technical service manager for Rigidex Polyethylene in place of Mr. P. Brown, who has taken over as sales manager for Cellomold, Rockite and Styron materials.

Distillers Plastics Group Appointments

Mr. S. R. Badley has been appointed market development manager, Distillers Plastics Group. Mr. Badley was formerly sales manager in charge of Binder Resins for British Resin Products Limited and this appointment has been taken over by Mr. C. D. Harvey-Piper.

Mr. L. R. Anthony has been appointed information officer and Mr. A. E. Oates, publicity officer, for the Distillers Plastics Group.

Davis and Thompson Ltd. Change of Name

WITH effect from 19th March, 1959, the name of this company has been changed to:

"Datum Metal Products Limited"

which title bears a closer relationship to its activities, namely, the design and manufacture of the "Datum" series of instrument racks, cases, control consoles, chassis and panels.

This change heralds a programme of expansion and forward progress in which the standard "Datum" ranges will be augmented by new designs and presentations, thus offering a wider choice of housings for electronic equipment.

Laboratory Equipment on Show at Bristol

QUICKFIT AND QUARTZ LTD., manufacturers of interchangeable laboratory glassware, of Stone (Staffs.), gave an exhibition of laboratory apparatus for research and teaching purposes at the Royal Institute of Chemistry meeting at the College of Technology, Ashley Down Road, Bristol, recently.

'Muscles of Control'

'Muscles of Control' is an instructional film in full colour. It has a running-time of about 25 minutes, and was produced for the Fisher Governor Company of Marshalltown, Iowa, U.S.A.

The introduction summarises the dependence of today's process industries on the automatic control valve—fundamentally, a device for controlling the flow of fluids in a process line. Working diagrams are used to support the narrative and the cameras use the flashback technique to switch to the laboratories where the importance of controlled research as an aid to accurate manufacture is emphasised.

Methods of manufacturing various valves for various functions are shown in detail. Some of the many technical difficulties in selecting the right valve for the right job, the underlying theme of the whole film, are demonstrated and explained. The advantages and disadvantages of single-port and double-port valves are discussed and the problems posed by the demand for differing types of inner-valves are pictorially analysed. Reference is also made to the effects of erosion, cavitation and vibration, and the way in which these effects are to a large extent overcome.

Many types of automatic valve actuators from the pneumatic spring diaphragm valve to the very latest electro-hydraulic device, are shown and dealt with in a lucid manner.

In the closing stages the film deals briefly with future trends, and points out that it is only by the continuous and concerted efforts of scientist, technician and engineer that the right automatic control valve can be manufactured for the right job. In the last resort a control valve is only as good as the care taken in its manufacture.

Increased automation in the process industries of the future, says the epilogue, depends more than ever on the efficiency and mechanical soundness of the automatic control valve.

Copies of this film are available on loan from the Fisher Governor Company Ltd., Airport Works, Rochester, Kent.

Silencing Feature for Air Movement Units

A method of sound deadening for their single and multi-stage axial flow air blowers and compressors used for temperature control throughout industry, has been evolved by Plannair Limited The significance of this development is that axial flow air movement units can now be used wherever high performance with quiet running is essential.

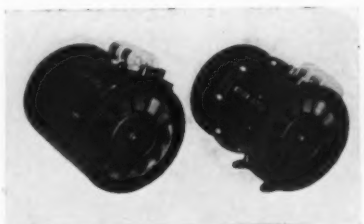
In applications where unsilenced axial flow units are already employed they may be supplanted by the new silenced units notably in new aircraft where the emphasis is increasingly on silence. The development will be particularly welcome in the computer field where the noise level from high output blowers has caused discomfort, even fatigue to the operators.

In solving the noise reduction problem Plannair have concentrated on reducing the amplitude of the vibrations over the 900-3,000 c/s range, which cause greatest discomfort. This they have achieved by packing the space confined by the exterior surface of the circular housing and end flanges with sound absorption material held in position by an outer wrapper plate. Noise vibrations are intercepted and absorbed by specially situated openings provided in the main blower housing.

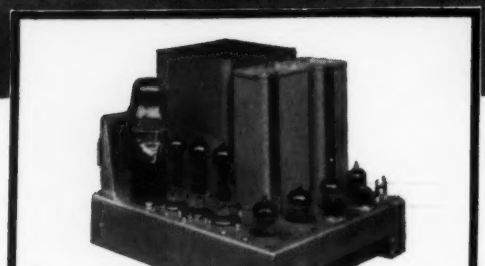
Tests on modified blowers have shown that the reduction in noise level is equivalent to approximately 15 decibels in the critical 900-3,000 c/s range. Where silenced blowers have been installed in equipment, satisfactory reductions in noise levels have been achieved.

Important features of the new development are that there are no external additions to be fitted to the equipment—the dimensions of the silenced blower are identical to that of a comparable unsilenced model—and there is no appreciable alteration in performance.

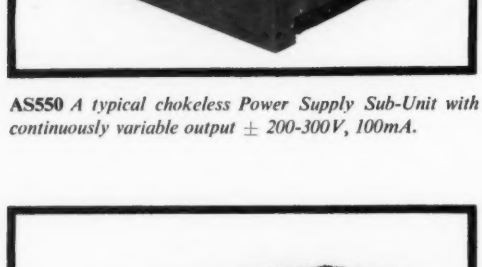
Plannair propose to incorporate the new silencing feature on all their standard equipment, as required. World patents have been applied for.



The six inch Plannair axial flow blower on the left is fitted with the new Plannair sound absorber, which reduces sound volume by approximately 15 decibels in the 2,000-3,000 cycles per second band. This model is no larger than the unmodified version shown alongside.



AS550 *A typical chokeless Power Supply Sub-Unit with continuously variable output ± 200-300V, 100mA.*



AS754 *A Sub-Unit giving ± 250-300V at up to 200mA.*

Solartron regulated power supply units offer a ready made and absolutely reliable source of packaged power, either for separate use, or direct incorporation into prototype and production equipment, including computers, simulators, industrial controls, etc.

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- ★ *Robustly made.*
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- ★ *Light, compact, inexpensive.*
- ★ *Easy to fit.*
- ★ *Exceptionally useful as bench instruments for educational and servicing establishments.*

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SOLARTRON

Mr. A. F. C. Williams

Mr. C. H. Noton

PERSONALITIES

Mr. R. S. Hewitt

Mr. R. S. Hewitt has joined the board of Elliott Brothers (London) Ltd. Mr. Hewitt started his career with Elliott Brothers in 1928 and is deputy controller of Elliott-Automation.

Mr. C. H. Noton

Mr. C. H. Noton, M.Sc., Ph.D., F.Inst.F., has been appointed commercial manager of Semiconductors Limited, Cheney Manor, Swindon. He will take over responsibility for the co-ordination of all commercial activities resulting from the rapid expansion of the company's interests in the manufacture of transistors and other semiconductor devices.

Mr. Noton was previously managing director of Genatosan Ltd. and before that, sales director of Fibreglass Ltd. During the war he served with the Royal Artillery, and was later with the Ministry of Economic Warfare and the Foreign Office.

President of Board of Trade

Sir David Eccles, K.C.V.O., M.P., President of the Board of Trade, accepted the invitation of the Aviation, Marine and Industrial Divisions of S. Smith & Sons (England) Ltd., and formally opened Kelvin House, Wembley, on Monday, 4th May.

Mr. H. K. Voss

Mr. H. K. Voss, technical director of Voss Instruments Ltd., Maldon (Essex). has just returned from a visit to their Continental agents. During his visit he appointed Mr. Wolfgang Zeh, Duisburg-Meiderich, Salmstrasse 12, as sole agent for Western Germany for their laboratory and industrial stirrers.

Mr. P. M. Garnier

Mr. Paul M. Garnier has been appointed general manager of Fred Ferraris (Clerkenwell) Ltd. as from the 6th April. He replaces Mr. Fred Wingfield who is no longer associated with the company.

Mr. A. F. C. Williams

Mr. A. F. C. Williams has been appointed technical sales representative for the North-Western Area of the British Central Electrical Co. Ltd.

Mr. Williams is an electrical engineer with a wide knowledge of the various departments of work within the company, and in particular of the various foreign technical electrical products for which the company holds U.K. agencies, which it has been his sole responsibility to handle.

Mr. J. E. C. Bailey's American Visit

Mr. J. E. C. Bailey, C.B.E., chairman and managing director of Baird and Tatlock (London) Ltd. and Hopkin and Williams Ltd., left the United Kingdom on 18th April for Canada and the U.S.A.

While in America, Mr. Bailey addressed the Scientific Apparatus Makers of America at their annual conference at White Sulphur Springs, West Virginia. He spoke on the European Common Market, and how it will affect exports from non-member nations, including the United States.

Mr. A. A. Morris

Northey Rotary Compressors Ltd., of Parkstone, Poole, announce the appointment of Mr. A. A. Morris as sales manager.

PUBLICATIONS RECEIVED

Automation Today and Tomorrow: A Technical Survey of Current Progress. L. Landon Goodman, 280 pp. 1959, 40s.
The first part of this book examines recent developments in the automatic factory and surveys future trends. It shows from case histories over a wide range of industries how automation may be applied inexpensively in the small plant. The second part is an extensive bibliography of books, papers and articles. There are author and subject indexes.

de Havilland Gazette (110), April, 1959.
Comet 4 electrical power system.
Comet 4 radio installation.

Marconi Instrumentation, 7 (1), March, 1959.
Circuit magnification meter type TF 1245 . . . with oscillators types TF1245 and TF1247. J. M. Parkyn.
Intermodulation testing using the Marconi white noise test set type OA1249A. G. Roper.
The uses of travelling-wave-tube amplifiers. L. M. Sargent.

Marconi Instruments, 1959.
This 308-page catalogue is divided into the following sections: signal sources; test sets; voltage measurement; impedance measurement; transmission measurement; waveform analysis; frequency measurement; power measurement; auxiliary equipment; moisture and pH measurement; industrial X-ray apparatus; and associated companies and distributors. There is a comprehensive index.

Muirhead Technique, 13 (2), April, 1959.
Impedance and phase angle of loudspeaker loads. R. E. Cooke.

Panorama (Constructors John Brown Ltd.), 2 (1), Spring, 1959.
The Engineering Division.

Platinum Metals Review, 3 (2), April, 1959.
Cathodic protection applications using platinum anodes. H. S. Preiser.
Lead-platinum bi-electrodes. L. L. Shreir.
Electrochemical properties of the platinum metals. M. J. N. Pourbaix, J. van Muylder and N. de Zoubov.
Temperature control in the Ford foundry. H. Connor.

Towers Laboratory News, No. 2 (Third series).
New vacuum pipeline systems.

Watch and Clock Yearbook, 1959.
This 144-page yearbook contains a buyers' guide and trade names directory and short articles.

Wild Barfield Heat-treatment Journal, 7 (50), March, 1959.
Modern heat - treatment equipment. L. G. W. Palethorpe.
Electric furnaces in the motor vehicle industry.

SOCIETY OF INSTRUMENT TECHNOLOGY

South Yorkshire Section

SEVENTY-SEVEN members and guests attended the first Annual Dinner of the South Yorkshire Section of The Society of Instrument Technology which was held at the Royal Victoria Station Hotel, Sheffield, on the 24th March, 1959.

After a very enjoyable meal, Dr. Charles Sykes, Managing Director of Thomas Firth & John Brown Limited, proposed a toast to the Society and, when reviewing progress in Instrument Technology and education of operatives in the use of instruments, he stressed the important role the Society had to play in providing the Instrument Technologists of the future.

Mr. J. F. Coales, President of the Society, replied to the toast and compared the effort in instrument technology in Russia and the U.S.A. with Great Britain, saying that he regretted that many of the new ideas in the instrument world were coming from overseas and that the Society must help to provide instrument technologists of the future to keep Great Britain abreast of the rapidly moving science of instrument design and application.

The Chairman of the Section, Mr. W. R. Owen, proposed a toast to the guests and thanked the many people who had come to the dinner for making it such a success. Mr. Owen stressed the importance of obtaining recognition for the Society and adding to its national prestige. He said that the South Yorkshire Section was very honoured to have so many distinguished people attend their first dinner and he specifically thanked the speakers and Mr. D. A. Oliver, Director of Research for the B.S.A. Group, and Mr. R. S. Medlock, Director of George Kent Limited, for lending their support.

Mr. H. C. Pritchard, Managing Director of the Cambridge Instrument Company Limited, replied with an entertaining speech on his experiences in Australia where he was Chief Superintendent of the Woomera Rocket Range. Mr. Pritchard thanked the Section on behalf of all the guests present and wished the South Yorkshire Section every success in the future.

Instrumentation at Billingham

AT the close of the business of the Annual General Meeting the chairman, Mr. W. R. Owen, said that his last duty gave him great pleasure and he thereupon called upon Mr. C. H. Gregory, the manager of the Instrument Department of I.C.I. Billingham and the chairman of the Tees-side Section of the Society, to deliver his lecture on Instrumentation and Automatic Control at I.C.I., Billingham.

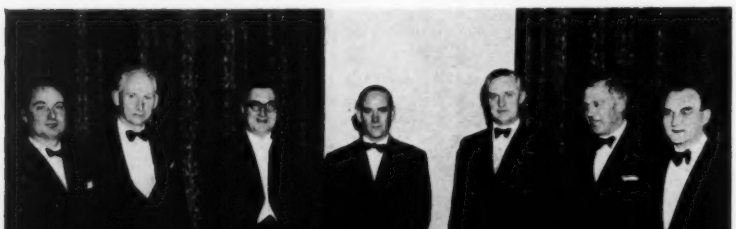
In his introductory remarks, Mr. Gregory gave his audience some idea of the scale of instrumentation at Billingham when he stated that there were between two and three million pounds worth of instruments looked after by a staff of 400. Of these instruments some 1,000 to 1,500 are automatic controllers, 7,000 to 8,000 flow controllers and they cover a wide range of conditions with temperature and pressure ranging from −200 to 1,300°C and 4 to 5,000 pounds per square inch. Many of the process fluids are highly corrosive and few approach the ideally clean fluids with which it is easy to obtain accurate measurement.

In the past twenty-five years, the attitude to instrumentation at Billingham has undergone a complete change. In the past the instrument was scarcely tolerated and then only as a scapegoat on which to hand the blame for any trouble. Now everyone wants more and more instruments and the chief difficulty is to cut down the number to essentials so that the maintenance force can be concentrated.

Initially the instruments consisted of simple indicators set near to manually controlled valves, etc. This principle has been retained but the recorders and controllers are now mounted in central control rooms so that the operator is provided with all the information enabling him to take rapid and accurate corrective action should the need arise. This system also protects the operator under emergency conditions and enables him to remain on the job and to effect a safe shut-down of the faulty section of the plant.

The main purpose of plant instrumentation is to measure and then to apply the measurement either manually or automatically to process control. Accurate measurement is therefore the first essential and it is easier to design a data logger than it is to measure a flow precisely.

Mr. Gregory then dealt with instrumentation under the headings of flow, temperature, pressure and analysis and he drew a distinction between the normal routine instrument used for plant control and the more accurate instrument used for costing and accountancy purposes. The latter are much more complex and require a high degree of maintenance if they are to give an accuracy approaching 1-2%. For this reason this category of instrument is strictly limited and for plant control purposes reliability and consistancy rather than absolute accuracy is the aim.

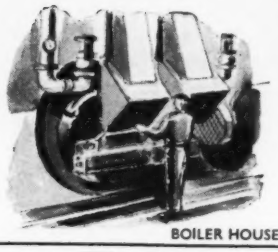


LEFT TO RIGHT:—
J. Blake, Secretary of the South Yorkshire Section, Land Pyrometers Limited.
D. A. Oliver, Director of Research, B.S.A. Group.
Dr. Charles Sykes, C.B.E., D.Sc., Ph.D., F.R.S., Managing Director of Thomas Firth and John Brown Limited.
W. R. Owen, Chairman of the South Yorkshire Section, Honeywell Controls Limited.
H. C. Pritchard, B.A., F.R.A.E.S., Managing Director of Cambridge Instrument Company.
J. F. Coales, O.B.E., M.A., M.I.E.E., F.Inst.P., President of the Society, University of Cambridge.
R. S. Medlock, B.Sc., A.R.I.C., A.M.I.E., A.M.I.Mech.E., Director of George Kent Limited.

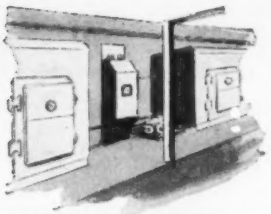
Circle 57 for further information

Rototherm

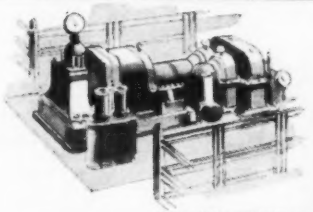
The DIAL THERMOMETER



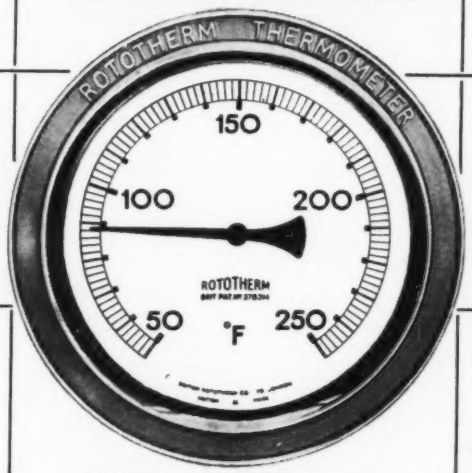
BOILER HOUSES

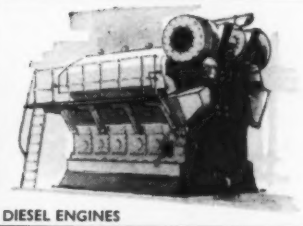


REFRIGERATION & COLD STORAGE

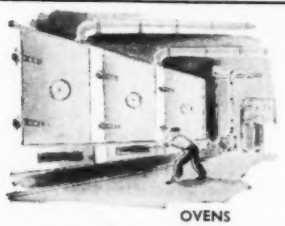


PUMPING STATIONS





DIESEL ENGINES



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In general, flow measurement is usually carried out with simple orifice plates, the more precise installations mentioned above being catered for by Pitot tubes, Venturis, Dall tubes and nozzles. Temperature measurement is almost exclusively made by iron/constantan thermocouples, in the medium range, on account of their simplicity and ease of replacement. Low ranges are catered for by resistance elements and high temperatures by precious metal couples. In some places where there is a high explosion hazard, gas, liquid or vapour pressure elements are used, but due to the cost of their associated transmitters, thermocouples are preferred wherever possible.

At one time analytical control was exercised by taking periodic samples, analysing them in the laboratory and then taking the requisite action, in most cases this procedure involved a time lag of some hours and a big plant running off the desired point for this time can be very expensive. Now, much of this analytical control is exercised by gas and liquid conductivity measurement, infra-red and ultra-violet absorption measurements, gas-liquid chromatography and, in some isolated cases, plant mass-spectroscopy for the complex hydrocarbons. In the future the company will require density and conductivity meters, ultra-violet, infra-red and gas-liquid chromatography apparatuses, automatic titrimeters and automatic distillation point recorders.

In many cases the cost of the instruments is low compared with the housing required for them, particularly where corrosive or explosive atmospheres prevail.

Mr. Gregory then went on to discuss the criteria upon which the need for and type of an instrument should be decided and he enumerated the criteria as follows:—

(a) Why is an instrument needed? If there is no disturbance there is no need to exercise control.
(b) What accuracy of control is required? This is seldom known and plant engineers tend to specify for more stringent requirements than they actually require.
(c) What type of control needs to be exercised? In other words, can a small disturbance be tolerated over a lengthy period or is a large disturbance for a very brief period the aim?

By following these simple rules, experience has shown that in most cases a normal commercial instrument of the correct type can be installed with no more than initial teething troubles.

The logical extension of plant instrumentation is to feed the output from the various measuring points into a special computer into which is built the mind of the plant manager, who, at present, orders the set points to be altered a degree up or down in accordance with a set of rules which he has formulated by experience. This type of computer presents great difficulties in design, but there is no doubt that it will be realised in the future.

In dealing with the problems of instrumenting new plants, Mr. Gregory mentioned that a philosophical approach is most necessary, particularly as the cost of instrumentation has risen from the 2-5% of twenty years ago to 5-15% today. This increase is quite defensible, as a fully automatic continuous flow process eliminates the need for storage tanks and pumps between stages and the outcome is therefore, a smaller plant with a reduced capital cost.

The expenditure on instruments can be justified by any one of four reasons, namely:—

(i) an aid to production
(ii) enabling the product to meet a quality specification without the need for re-processing
(iii) for safety reasons
(iv) to reduce costs.

The first two of these reasons are self-explanatory, but the meaning of (iii) is not quite so self evident. Taking for instance, the oxidation of ammonia in which a mixture of 14·5% ammonia with oxygen is highly explosive, while 12% produces a good conversion rate, it is necessary to work as near to the danger point as possible in order to obtain efficient conversion so that the instruments are designed to run the plant at a 12% mixture and to shut it down should the concentration rise to 12·5%.

In reducing production costs it will be difficult to proceed further with the replacement of labour by instruments. The aim must now be to improve efficiency.

After dealing with the training of instrument technicians and engineers at Billingham, Mr. Gregory then concluded his lecture with a series of slides showing the old and the new together with some of the centralised control rooms and the wiring and air lines behind the panels.

A lively discussion followed in which many contributors mentioned that it was refreshing to hear a man of Mr. Gregory's standing stating the practical limits in the accuracy of measurement, a feature often forgotten.

Automatic Control System—by Pneumatics

Automatic control, or 'automatic watchkeeping'—that is, the system of maintaining sustained observation by instruments on remote mechanical functions—is popularly regarded as being the prerogative of electronics.

Cheltenham Auto Controls Ltd. has recently developed a new system of automatic control which uses a well-tried and cheap power medium—compressed air.

It is a system of maintaining continuous remote observation, especially in inaccessible locations of vital functions such as bearing oil temperatures and levels, axial movement of turbine shafts, critical pressures, flowrates and levels. Each function—hitherto entailing periodic inspection by a watchkeeper is detected with a force-balance pneumatic transmitter, which sends a signal by small bore tubing to a distant indicating station. This station displays the observations on suitably engraved dials.

Some typical applications of this pneumatic control system are for instance, in the brewing, milling and food manufacturing industries; the accurate control of boiler plant and those other processes which demand a constant check on such variables as liquid levels, draughts, steam pressures, temperatures, flow rates and so on. Indeed, the pneumatic system can often replace, with positive advantages, the more complicated electronic systems of automatic control.

The Force-balance Transmitter

This beamless pneumatic instrument, developed by the Cheltenham company, consists of the function-detecting input unit, and a transducing element which converts the observation into a pneumatic signal. The transmitter uses hydraulically-formed bellows instead of rubber diaphragms. The distantly located indicating panel also carries an arrangement of trigger relays. These may be set so that they trip when an incoming signal denotes approach to a danger limit; and their action causes an audible and visual alarm station to operate.

It is important to note that this system is intrinsically safe; it is so arranged that even a breakdown of one of the constituent units will cause the alarm to operate and to indicate the source of the fault.

Turbine Axial Movement

Considerable damage may be incurred in a turbine if the rotor blades, which are mounted on the shaft, should move axially and so brush against the stationary blades. On a ship such a breakdown can result in endless difficulties.

Cheltenham Auto Controls Ltd. have introduced a pneumatic detector which observes the axial position of the turbine shaft, and transmits the reading to a conveniently located dial gauge. A shaft movement of as little as one thousandth of an inch is immediately indicated by a bold pointer movement on the gauge.

The shaft axial movement indicator is never in metallic contact with the shaft, and is separated by an air cushion. High speed shaft rotation does not in any way prevent the instrument from giving a true reading.

Automatic Control

Automatic watchkeeping may be extended to incorporate automatic control. For this latter purpose Cheltenham Auto Controls have designed a complete series of control elements, all pneumatically powered, and all using the conventional 3-15 p.s.i. pressure output. Their automatic controller accepts a signal from a transmitter, compares it with the desired function value, and then acts upon a regulating means (such as a valve) until any deviation from the desired value has been corrected. The controller performs a continuous stream of mathematical calculations in order to accurately control the regulating means; these calculations are made at considerable speed—as many as 3,000 calculus functions per minute.

Automatic control, as applied to an oil-fired boiler, ensures a constant steam pressure under varying load conditions. It also maintains continuous control of the burner fuel in a manner to promote maximum combustion efficiency.

Circle 59 for further information

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The TCVR is a servomechanical automatic voltage regulator having the very high speed of correction of FORTY VOLTS PER SECOND. It provides an *undistorted* output, maintained constant within very close limits (normally ±0.5%) from no-load to full-load, for wide variations in frequency and power factor.

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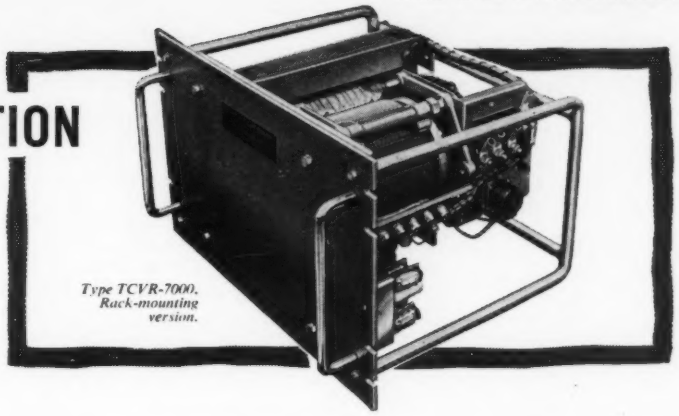
For high-speed, accurate stabilisation *without distortion*—**specify TCVR.**



Type TCVR-7000. Rack-mounting version.

Other products of Claude Lyons Ltd. Stabiliser Division

BMVR: Motor-driven laboratory and industrial regulators ranging from 1·6 to 29 kVA single-phase, and 4·8 to 87 kVA three-phase. Constancy of output normally ± 0·5% from no-load to full-load. No distortion. Speed of correction 1 Volt/Sec. A great variety of models, standard, tropical and militarised, for all applications.

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ASR: Automatic step regulators, small, inexpensive, and with sinusoidal output waveform. Two sizes : 1·15 kVA and 2·3 kVA. Input range − 10% to + 5%; output constancy, ± 2½%.

ATC: Automatic Tap-Changing Transformers — a development of ASR. Two sizes : 575 VA and 1150 VA. Input range − 20% to + 10% : output constancy, ± 5%. Provide adequate stabilisation for many types of apparatus, at low cost. Also useful as pre-regulators, e.g. in conjunction with BAVR.

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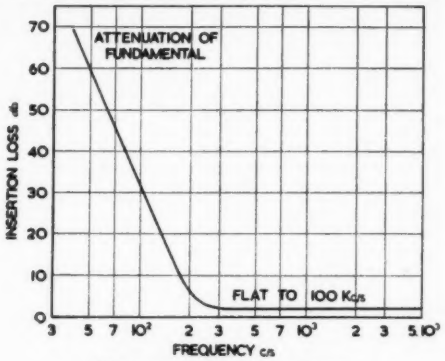

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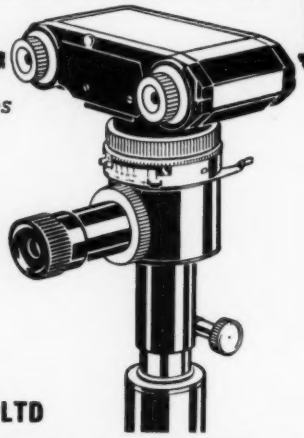

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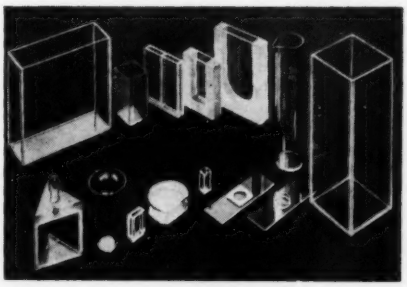

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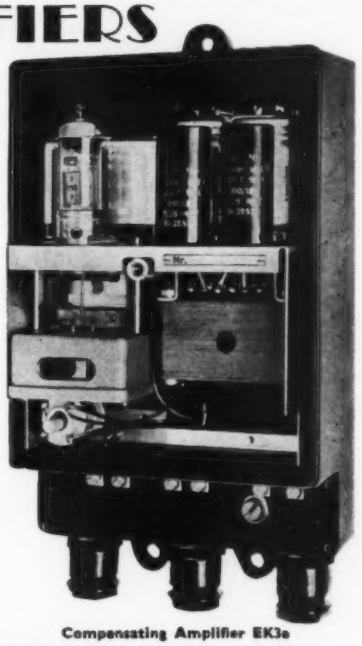

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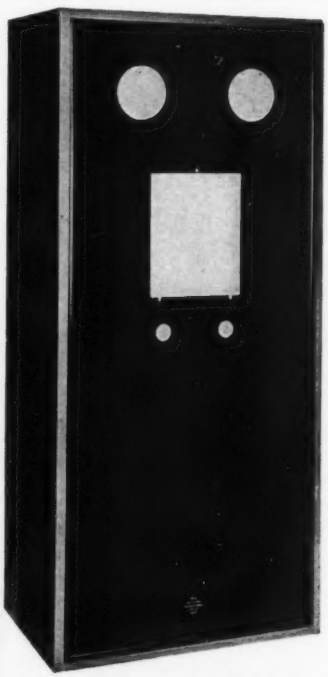

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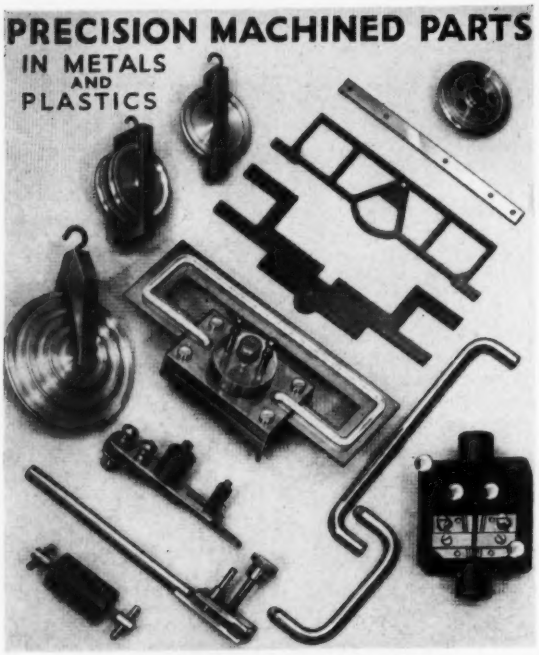

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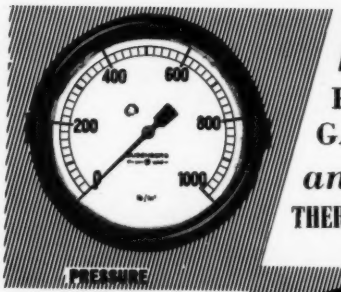

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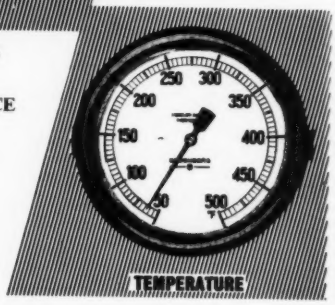

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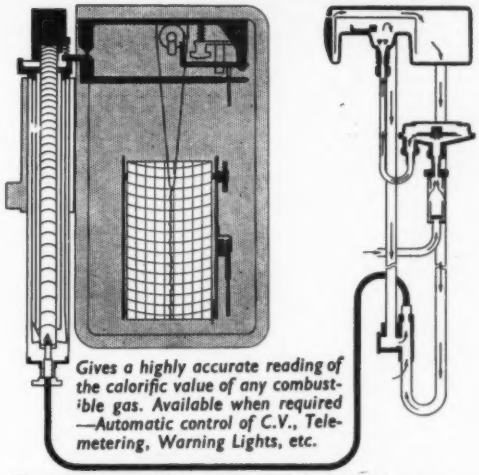

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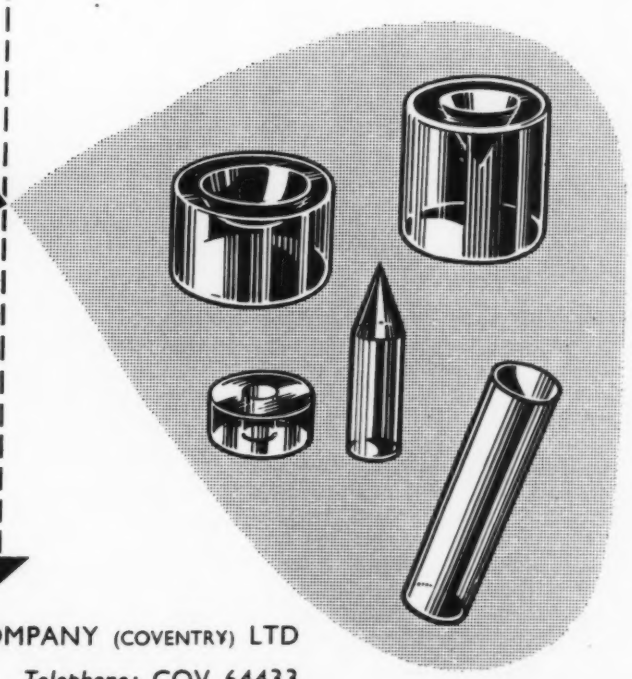

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CLASSIFIED ADVERTISEMENTS
continued on page 680

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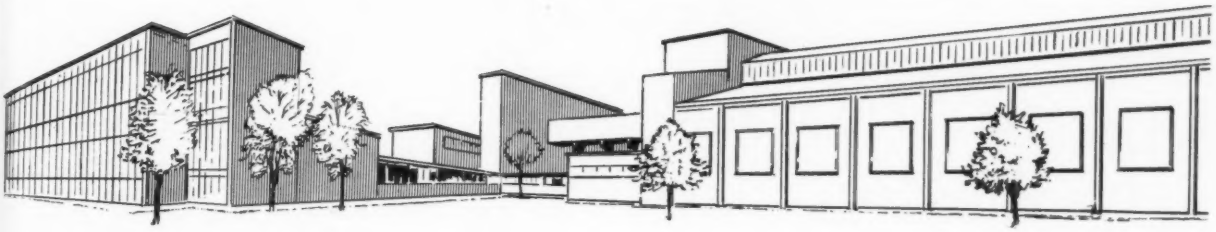

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Continued from page 678

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(Continued)

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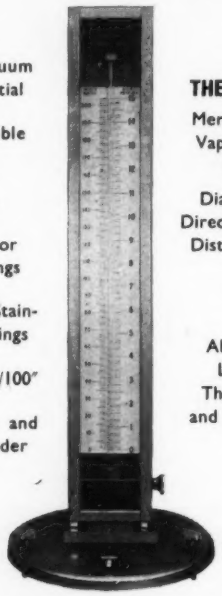

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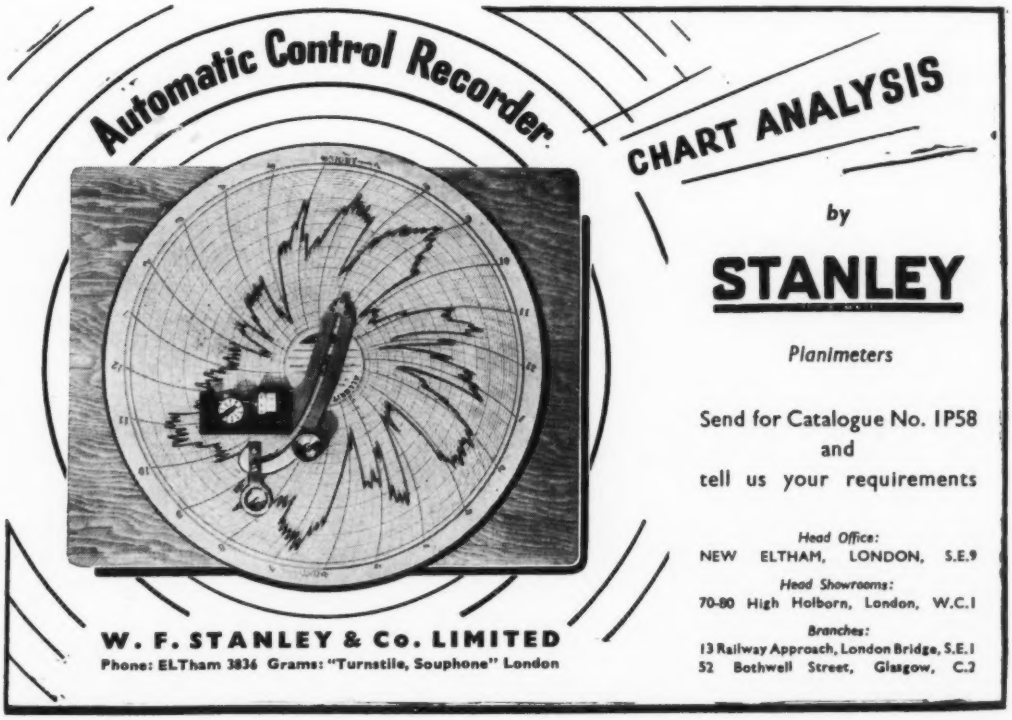
Circle 75 for further information

Circle 76 for further information

INDEX TO ADVERTISERS

	Page
Accurate Recording Instrument Co.	684
Advance Components Ltd.	583, 591
Alexander Controls Ltd.	596
Armstrong Whitworth Aircraft Ltd., Sir W. G.	603
Arrow Electric Switches Ltd.	May
Audley Engineering Co. Ltd.	607
Avo Ltd.	585
Baldwin Instrument Co. Ltd.	609
Bamford & Co. Ltd., F.	May
Barr & Stroud Ltd.	674
Beck Ltd., R. & J.	674
Bedford & Son, A. H.	682
Blakeborough & Sons Ltd., J.	601
Bough & Co. Ltd., F. S.	676
British Rototherm Co. Ltd., The	671
British Sonceboz Co. Ltd.	Inside Front Cover
Bryans Aeroquipment Ltd.	May
Budenberg Gauge Co. Ltd.	676
Cambridge Instrument Co. Ltd.	May
Clarke & Co. (Manchester) Ltd., H.	May
Classified Advertisements	678-9-680-1
Clifford Ltd., Charles	May
Coley Thermometers Ltd.	592
Constructors John Brown Ltd.	May
Counting Instruments Ltd.	646
Darton & Co. Ltd., F.	681
Dobbie McInnes (Electronics) Ltd.	592
Drayton Regulator & Instrument Co. Ltd.	May
Elcontrol Ltd.	606
Electro-Hydraulics Ltd.	674
Electronic Components	578
Electronic Switchgear (London) Ltd.	600
Elliott Brothers (London) Ltd.	May
English Electric Co. Ltd., The	573
English Glass Co. Ltd., The	May
Etherl Ltd.	579, 593
Firth Cleveland Instruments Ltd.	599
Fischer Bearings Co. Ltd.	677
Foster Instrument Co. Ltd.	590
Foxboro-Yoxall Ltd.	Front Cover
Gambrell Bros. & Co. Ltd.	May
Gas Council	May
General Electric Co. Ltd., of England, The	648
Gowlands Ltd.	May
Gow-Mac Instrument Company	May
Hendrey Relays Ltd.	604
Hilger & Watts Ltd.	602
Hoffmann Mfg. Co. Ltd., The	584
Honeywell Controls Ltd.	Back Cover
Hutcheon Duthie & Son Ltd., R.	Inside Back Cover
Imhof Ltd., Alfred	595
Integra, Leeds & Northrup Ltd.	656
Johnson, Matthey & Co. Ltd.	May
Jones & Co. Ltd., Samuel	588
K.D.G. Instruments Ltd.	594
Kent Ltd., George	May



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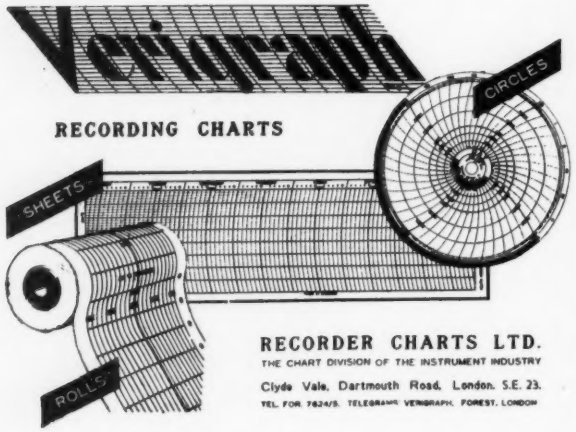

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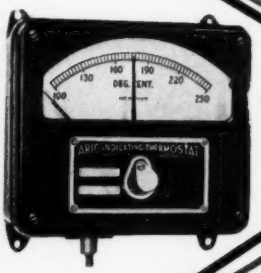

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INDEX TO ADVERTISERS *(continued)*

	Page
Langham Thompson Ltd., J.	May
Laurence, Scott & Electromotors Ltd.	May
Lee & Co. (Coventry) Ltd., Fred	677
Lewis & Co. Ltd., H. K.	680
Lindsey Ltd., C. S.	681
Lloyd Parkinson Ltd.	May
Londex Ltd.	600
Lyons Ltd., Claude	673
Malcolm & Allan Ltd.	May
Marconi Instruments Ltd.	671
Metropolitan-Vickers Electrical Co. Ltd.	587
"Monitor" Patent Safety Devices Ltd.	May
Morris (Clerkenwell) Ltd., John	680
Murex Ltd.	May
Myford Engineering Co. Ltd.	673
Nalder Bros. & Thompson Ltd.	May
Negretti & Zambra Ltd.	577
Newall Group Sales Ltd.	612
New Electronic Products Ltd.	May
New Western (Engineering) Ltd.	675
Norgren Ltd., C. A.	598
Painton & Co. Ltd.	589
Payne & Griffiths Ltd.	602
Premier Screw & Repetition Co. Ltd.	May
Pullin & Co. Ltd., R. B.	May
Purdie & Son Ltd., E. J.	681
Pye & Co. Ltd., W. G.	605
Pyrotenax Ltd.	586
Recorder Charts Ltd.	684
Research & Control Instruments Ltd.	594, 604
Rotameter Manufacturing Co. Ltd.	660
Rubert & Co. Ltd.	May
Rundle (Upper Norwood) Ltd., A.	680, 681
Sangamo Weston Ltd.	676
Savage Ltd., W. Bryan	608
Scott & Co. Ltd., A. C.	581
Scott & Co. (Electrical Engineers) Ltd., James	580
Short & Mason Ltd.	May
Sifam Electrical Instrument Co. Ltd.	May
Sigma Instrument Co. Ltd.	677
Simplifix Couplings Ltd.	608
Smith & Sons (Nottingham) Ltd., Sydney	582
Solartron Electronic Group Ltd., The	668
Spencer Components	681
Stanley & Co. Ltd., W. F.	680, 683
Stern Instruments (Great Britain) Ltd., C. T.	675
Sunvic Controls Ltd.	664-5
Taylor Controls Ltd.	610
Taylor Electrical Instruments Ltd.	596
Taylor & Francis Ltd.	May
Technograph Electronic Products Ltd.	May
Telegraph Construction & Maintenance Co. Ltd., The	598
Telephone Manufacturing Co. Ltd.	597
Texas Instruments Ltd.	614
Thompson Instrument Co. Ltd., John	May
Turner Electrical Instruments Ltd., Ernest	576
United Science Press Ltd.	May
Wade Couplings Ltd.	May
Watson & Sons Ltd., W.	May
Westool Ltd.	574-5
Whilems Ltd., C. J.	674
Woden Transformer Co. Ltd.	606
Woodhill Engineering Co. Ltd.	682
Zeal Ltd., G. H.	682

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r., DUBLIN

Page
676
608
581
580
May
May
677
608
582
668
681
680, 683
675
664-5

610
596
May
May
598
597
614
May
576

May

May
May
574-5
674
606
682

682